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Understanding the Characteristics of Low Income Households Most at Risk from Living in Cold Homes

Final Report to the Welsh Government: Main Report

Understanding the Characteristics of Low Income Households Most at Risk from Living in Cold Homes: Final Report to the Welsh Government

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Views expressed in this report are those of the researcher and not necessarily those of the Welsh Government

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Table of contents

List of Tables.....	ii
List of Figures.....	iv
Glossary of acronyms.....	v
1. Introduction	1
2. Methodology.....	5
3. Phase 1: Understanding, identifying and targeting households most vulnerable to living in cold homes.	13
4. Phase 2: Modelling energy improvement schemes targeted at the eligible households.....	52
5. Conclusions and recommendations	80
6. Reference section	90
Annex A.....	94
Annex B	133

List of tables

Table 2.1: Search terms used to gather literature for the evidence assessment during Phase 1	6
Table 2.2: Maximum spending caps used during the NHM modelling for dwellings receiving energy efficiency measures by energy efficiency band and for different annual scheme budgets.....	11
Table 3.3: Relative low income thresholds for different household types in Wales (before housing costs)	22
Table 3.4: Summary of ways to demonstrate eligibility for main types of vulnerable household	40
Table 3.5 Household types qualifying for energy efficiency measures under the proposed eligibility criteria	42
Table 3.6 The targeting efficiency of recent energy efficiency schemes	43
Table 3.7 Number of households by qualifying benefit or condition and by household type for private rented or owner occupied dwellings in SAP bands E, F or G (SAP rating < 54) ^a	44
Table 3.8 Number of households by qualifying benefit or condition and by household type for private rented or owner occupied dwellings in SAP bands D, E, F or G (SAP rating < 68) ^a	45
Table 3.9 The numbers of households and median income for different groups of households, split by eligibility for the scheme, for private rented or owner occupied dwellings in SAP bands E, F or G (SAP rating < 54).....	46
Table 3.10 The numbers of households and median income for different groups of households, split by eligibility for the scheme, for private rented or owner occupied dwellings in SAP bands D, E, F or G (SAP rating < 68)	46
Table 3.11 Summary of the eligibility criteria by proposed scheme budget.....	48
Table 4.12 Household Characteristics and Energy Efficiency Rating for Eligible groups by annual scheme budget.....	54
Table 4.13 Average estimated energy efficiency ratings, energy bills and domestic carbon emissions by household type.....	55
Table 4.14 Average cost of measures and bill reduction by household type; annual scheme budget: £10 million ^a	57

Table 4.15 Improvements in SAP, emissions and fuel bills after installation of measures, by initial heating fuel and SAP band - annual scheme budget: £10 million	58
Table 4.16 Average cost of measures and bill reduction by household type - annual scheme budget: £25 million ^a	61
Table 4.17: Improvements in SAP, emissions and fuel bills after installation of measures, by initial heating fuel and SAP band - annual scheme budget: £25 million	62
Table 4.18 Average cost of measures and bill reductions - annual scheme budget: £50 million	65
Table 4.19 Improvements in SAP, emissions and fuel bills after installation of measures, by initial heating fuel and SAP band - annual scheme budget: £50 million	66
Table 4.20 Average cost of measures and bill reduction - annual scheme budget: £100 million	71
Table 4.22 Number of eligible households, average expenditure and impact on energy bills by scenario	73
Table 4.23 The type and number of measures installed by scenario ^a	74
Table 4.24: The proportion of low income and vulnerable households receiving measures by budget scenario.....	76
Table 4.25 Impact on average annual energy bill by household type - all eligible households (not only those receiving measures).....	77
Table 4.26: Impacts on average SAP rating by household type - all households.....	78

List of figures

Figure 3.1: Low income households and vulnerable groups 24

Figure 3.2: Energy efficiency ratings and SAP bands of dwellings..... 28

Figure 4.3 The proportion of dwellings in each SAP band over the lifetime of a
scheme - annual budget: £10 million (all eligible households n = 21,407)... 59

Figure 4.4: The proportion of dwellings in each SAP band over the lifetime of a
scheme - annual budget: £25 million (all eligible households - n = 36,725). 63

Figure 4.5: The proportion of dwellings in each SAP band over the lifetime of a
scheme - annual budget: £50 million (all eligible households - n = 68,139). 67

Figure 4.6: The proportion of dwellings in each SAP band over the lifetime of a
scheme - annual budget: £100 million (all eligible households - n = 110,674)
..... 72

Glossary

Acronym/ Key word

Definition

ASHE	Annual Survey of Hours and Earnings
ASHP	Air source heat pump
BME	Black and Minority Ethnic
BRE	Building Research Establishment
CERT	Carbon Emissions Reduction Targets
COPD	Chronic Obtrusive Pulmonary Disease
CSE	Centre for Sustainable Energy
CVA	Cerebral Vascular Accident
DALYs	Disability Adjusted Life Years
DCLG	Department for Communities and Local Government
DECC	Department for Energy and Climate Change
DIMPISA	Distributional Impacts Model
DWP	Department of Work and Pensions
ECO	Energy Companies Obligation
EHS	English Housing Survey
EPC	Energy Performance Certificate
ESA	Employment Support Allowance
EWD	Excess Winter Deaths
HBAI	Households Below Average Income
HMRC	HM Revenues and Customs
HRP	Household Reference Person
LIHC	Low Income High Costs (fuel poverty definition)
LIW	Living in Wales survey
LPG	Liquid Petroleum Gas
LSOA	Lower Super Output Area
NCB	National Children's Bureau
NEA	National Energy Action
NHM	National Household Model
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
OECD	Organisation for Economic Co-operation and Development
ONS	Office for National Statistics

PV	Photo Voltaic
SAIL	Safe and Independent Living
SAP	Standard Assessment Procedure
SDA	Severe Disablement Allowance
WHD	Warm Home Discount
WHO	World Health Organization
WIMD	Welsh Index of Multiple Deprivation
VOA	Valuation Office Agency

1. Introduction

- 1.1 The People and Environment Division is part of the Natural Resources Group within the Welsh Government. It leads on the implementation of the Minister's commitment to create sustainable places, and its work encompasses sustainable behaviours and engagement, energy efficiency and fuel poverty, local environmental quality and radioactivity & pollution prevention.
- 1.2 The Energy Efficiency and Fuel Poverty branch is responsible for policy on both energy efficiency and fuel poverty and manages delivery of Welsh Government Warm Homes, which includes the Nest and Arbed schemes.
- 1.3 The Welsh Government's Fuel Poverty Strategy, published by the Welsh Government in 2010, outlined an approach to reducing the number of households in Wales who are living in fuel poverty. It also set out plans for meeting the statutory obligation to do everything reasonably practicable to eradicate fuel poverty in all households in Wales by 2018.
- 1.4 The Centre for Sustainable Energy (CSE) is an independent national charity established in 1979 to tackle climate change and fuel poverty. The organisation has a history of analysing national policy, fuel poverty research and modelling experience, alongside practical energy efficiency scheme delivery. CSE provided expert input to the development of the new National Institute for Health and Care Excellence (NICE) health sector guidelines on cold homes. In 2014, CSE won the inaugural Ashden Award for outstanding contribution to addressing Fuel Poverty.
- 1.5 CSE is a leading expert in fuel poverty and housing modelling using big datasets. CSE built the National Household Model (NHM) for the Department for Energy and Climate Change (DECC), an analytical tool for housing stock and occupant types across Great Britain, which DECC uses to underpin its policymaking. CSE also developed the Distributional Impacts Model (DIMPSA) which is now used routinely by DECC and Ofgem to assess the impacts of national policies on different groupings of households.

- 1.6 In 2015, the Welsh Government commissioned CSE to conduct a piece of work focusing on developing a better understanding of which low income households are the most vulnerable from living in cold homes and in the greatest need of a home energy efficiency intervention. A key aim of the research is to inform decision making around the development of a future demand-led energy efficiency scheme. This includes considering an effective eligibility criteria to reach these vulnerable groups and focusing on how to best provide support to these people through targeted home energy efficiency improvements.
- 1.7 There are currently two key domestic energy efficiency schemes in operation across Wales that work alongside the UK-wide policies of the Green Deal and the Energy Companies Obligation (ECO). These are the demand-led Welsh Government Warm Homes Nest scheme and the area-based Welsh Government Warm Homes Arbed schemes.
- 1.8 Warm Homes Nest started on 1 April 2011 and continues to provide qualifying householders with a 'whole house' package of energy efficiency improvements at no cost to the household. The policy is targeted at various low income people living in energy inefficient dwellings. It uses means tested benefits to identify potential eligible households, and follow up housing surveys to check the efficiency level of dwellings and the interventions required. It includes a range of energy efficiency measures, and combinations of these 'packages of measures' can be tailored to the requirements of each dwelling. Packages are designed to take a property to band C within spending thresholds for individual properties. Warm Homes Nest also provides a range of advice and support services to help householders reduce their fuel bills, and can also refer eligible householders to other schemes for free or subsidised home energy improvements.
- 1.9 Warm Homes Arbed is an area-based scheme, looking to target people in some of the most deprived areas of Wales, identified using the Welsh Index of Multiple Deprivation (WIMD). Householders cannot apply directly for support; rather, Arbed funds projects that have been submitted by local

authorities. It helps households by improving insulation, replacing inefficient boilers, switching homes to more affordable or renewable fuel types and installing energy efficient heating systems.

- 1.10 In addition to these schemes, the Welsh Government published a Fuel Poverty Strategy in 2010 which has the statutory obligation for the Welsh Government to eradicate fuel poverty where reasonably practicable by 2018.
- 1.11 The NEST scheme is now into its sixth year and has achieved significant success in delivering its stated objectives, as described in annual reports¹ and an evaluation of the scheme published in March 2015 (Welsh Government, 2015). Nevertheless, several potential areas for improvement have been identified and the Welsh Government is looking to answer a series of questions regarding the future of the scheme. In particular, it is interested in better understanding who are the people most at risk and most vulnerable from living in cold homes and what are the options for targeting these groups effectively.
- 1.12 The research has been broadly split into two main phases. The first phase analysed existing literature, previous research and national data sets to explore the latest evidence and characterise groups of people who suffer the most from living in cold homes. This phase of the research included an investigation of potential routes to reach these households and to make recommendations on potential eligibility criteria to use for targeting an energy efficiency scheme at the vulnerable people identified.
- 1.13 The second phase involved the creation of a housing stock database for the NHM, representing all housing and households in Wales. The NHM was then used to model different energy efficiency scheme scenarios using different annual budget options.
- 1.14 The report is initially intended to assist and inform Welsh Government decision making concerning the design of future energy efficiency schemes. It is also likely to be of wider interest to others involved in the

¹ <http://www.nestWales.org.uk/publications>

design and delivery of domestic energy efficiency retrofits and fuel poverty alleviation programmes.

- 1.15 This report does not present a complete design option of an energy efficiency scheme. Rather, it sets out evidence to inform a wider scheme development review. It includes discussion of different considerations in the design and operation of eligibility processes, as well as in the marketing and promotion of such eligibility-based schemes.
- 1.16 The methodology used for both phases is detailed in Section 2 of this report. A summary of the evidence assessment is presented in Section 3, while the full literature review and complete list of referenced material can be found in Annex A. Section 4 presents results and analysis of modelling an energy efficiency scheme in the NHM, and this includes an assessment of the impact on the different vulnerable groups identified in the evidence assessment. Finally, a series of conclusions and recommendations from the research are provided in Section 4.1.

2. Methodology

Phase 1: Understanding, identifying and targeting households most vulnerable to living in cold homes

Evidence assessment

2.1 A rapid evidence assessment was used to identify which groups were most at risk of living in cold homes and most vulnerable to the harmful effects of living in a cold home. The main purpose of this review was to explore and summarise the evidence that answers the following questions:

- Which groups are most likely to live in cold homes?
- Which individuals or households are most vulnerable to the harmful effects of living in cold homes?
- Which harmful effects of living in cold homes are these vulnerable individuals most susceptible to?
- What is their income status? / What proportion of these groups with high vulnerability to the harmful effects of cold homes also live in low income households?²
- What proportion of households contain members with more than one vulnerability characteristic?²

2.2 Table 2.1. The search for literature used the Google internet search engine. For example, the first search term might be: ("cold homes" OR "cold home") AND "vulnerable" AND "health", returning results which feature all terms "cold home" and "vulnerable" and "health" or all terms "cold homes" and "vulnerable" and "health".

2.3 The following criteria were used to include or exclude reports, papers and publications:

- The study must include the mention of cold homes AND identify a particular group of the population

² This information is to be predominantly determined through data analysis (see below).

- The research must have been completed not earlier than the year 2000.
- The research could focus on individual home countries in the UK, be UK-wide or be from abroad.
- Only the most recent study should be included where research is identified in more than one format.
- Academic studies must have been cited by other studies (as reported by Web of Knowledge)

Table 2.1: Search terms used to gather literature for the evidence assessment during Phase 1

Cold homes	Vulnerability	Impact
Cold homes/Cold home	Vulnerable	Health
	Elderly	Development
	Disabled/Disability	Social Exclusion
	Children	Depression
	Infants	Education
	Excess Winter Deaths	

N.B. For example, the first search term would be: ("cold homes" OR "cold home") AND "vulnerable" AND "health", returning results which feature all terms "cold home" and "vulnerable" and "health" or all terms "cold homes" and "vulnerable" and "health".

Data Analysis

- 2.4 To enhance the evidence from the literature, additional exploratory analysis was performed using several datasets. The datasets were analysed to explore the socio-economic characteristics of the groups identified in the literature review as vulnerable to the harmful effects of living in cold homes, and to test the reliability of the findings from the literature against current household datasets for Wales.
- 2.5 The datasets chosen for the analysis were those that could provide the most robust and relevant analysis. The datasets had to include all the variables required to identify different vulnerable groups, including some

information on housing and income levels. The selected datasets had to cover households in Wales, either fully or partially, and must have been collected within the last 10 years. The main datasets used to profile households were:

- The Living in Wales (LiW) Survey 2008
- The Households Below Average Income (HBAI) 2013-14
- The National Survey for Wales, 2014-15

2.6 The LiW household survey was an annual survey carried out from 2004 to 2008. It was based on face to face interviews with the household reference person (HRP) or another appropriate adult in a sample of households across Wales. In 2004 and 2008 a property survey was also carried out, which meant that some respondents received a follow-up visit by a qualified surveyor to undertake a property assessment of their home. Both the household survey and the property survey were analysed as part of the research.

2.7 The HBAI survey provides information on potential living standards in the United Kingdom as determined by disposable income. It is a proxy for the level of consumption of goods and services that people could attain given the disposable income of the household in which they live. In order to allow comparisons of the living standards of different types of households, income is adjusted to take into account variations in the size and composition of the households in a process known as equivalisation.

2.8 The National Survey of Wales was the successor to the LiW Survey. It ran between January 2012 and April 2015 and annually conducted more than 14,000 interviews with a randomly selected sample of people aged 16 and over across Wales. The survey asked respondents about a range of topics. The information collected is used by the Welsh Government and others to inform the development of policy and the delivery of public services.

2.9 Information in the datasets was used to develop profiles of low income households and to ascertain the likely population size, average household income, average energy efficiency rating and fuel poverty ratios of different

types of vulnerable groups and the dwellings they inhabit. This included analysis of the overlaps between different types of vulnerability.

Identifying and targeting qualifying households

- 2.10 Having identified the group which the scheme should ideally target, a mechanism for identifying, targeting and engaging with these households was also considered as part of Phase 1. A series of targeting systems were considered and an eligibility scheme designed taking into account administrative costs and the levels of targeting efficiency. The recommended system for households qualifying for a future scheme was then used during Phase 2 of the project, which modelled a future energy efficiency scheme.

Phase 2: Modelling energy improvement schemes targeted at qualifying households

- 2.11 In 2012, DECC commissioned CSE to develop a domestic energy policy modelling and analytical tool to cover the whole of GB. The result was the NHM which is now an integral domestic energy policy modelling and analytical tool used by DECC.
- 2.12 The NHM uses national housing condition survey data to create a detailed representation of a particular housing stock and its occupants. It combines this with a domain-specific and highly flexible modelling language that enables analysts to create policy scenarios and explore the potential impacts on domestic energy demand (and associated bills and emissions) over time. A key component of the NHM is the 'energy calculator' which calculates energy use by fuel and energy service at household level, based on the BREDEM-8 (2001) and Standard Assessment Procedure (SAP) 2009 algorithms.

Creating a housing stock representing Wales in the NHM

- 2.13 Prior to this project, there was no existing housing stock for Wales in the NHM. As a result, a housing stock representing all housing and households in Wales was created for this project. The latest property survey for Wales was conducted in 2008 as part of the LiW survey, and much of this data is

now out of date. Nevertheless, it contains some unique information about aspects of homes and households in Wales and was used as a basis for the stock production.

- 2.14 Some household characteristics are of central importance to this project. For example, household income was used as a key variable in the stock production process. Incomes in the LiW 2008 survey were updated to align with the survey years covered in the English Housing Survey (EHS), using Annual Survey of Hours and Earnings (ASHE) data.
- 2.15 Key variables in the LiW property and households surveys were used as a basis for procedural selecting and reweighting of a subset of cases from the EHS (2012-13), with the final result resembling the LiW 2008 distributions of key variables. A full description of the reweighting process used to produce a Wales housing stock can be found in Annex B.
- 2.16 The reweighting of England cases allows representation of energy efficiency levels in the year of the EHS, i.e. 2012-13. In order to represent the housing stock in 2015, an additional pre-modelling scenario was also run to model domestic measures that have been installed in Wales since 2012, using information from national policies (Nest, ECO and Green Deal) and any additional information available for schemes in Wales. Information available on different scheme funding streams was used to minimise double counting of measures installed.

Modelling an energy efficiency scheme

- 2.17 The process of producing a stock for Wales ensured that key socio-demographic information relevant to this research was captured and included in the stock. This included information on incomes, benefits claimed, whether households contained people with disabilities or long term illnesses, and the ages of children and adults. This allowed the simulation of a targeting process using eligibility criteria to reach households identified in the literature as vulnerable. The specific eligibility criteria used in the modelling is discussed in more detail in Section 3.

- 2.18 To summarise the process, the NHM allows dwellings (or households) in the stock to be 'flagged'. These flags can be called upon when specifying which households to apply certain actions to, such as installing energy efficiency measures. The flags can be applied to households based on a series of criteria and information that exists in the stock. Throughout the modelling, flags were assigned to a subset of households qualifying for assistance.
- 2.19 Four annual spending budgets of £10 million, £25 million, £50 million and £100 million were investigated, with the scheme running over a five year period. The targeting of vulnerable households was adjusted to increase the size of the eligible group in line with increasing scheme budgets. The groups deemed to have the highest priority were included for the lowest budgets and then additional groups with lower priority levels added to the eligible pool of households as scheme budgets increased.
- 2.20 The model selects households for measure installation using a random sampling approach from all households who are eligible under a certain spending cap. This means if the model is run multiple times, then results will differ slightly
- 2.21 In addition, maximum spending caps were applied to dwellings of different energy efficiency ratings and using different main heating fuels. The maximum expenditure for different types of dwellings is shown below in Table 2.2. Reducing the cap for more efficient dwellings helped to ensure that these dwellings did not disproportionately use up the funding available and also recognises that the least efficient properties require higher levels of investment to bring them up to adequate levels of efficiency. For the £100 million spending limit, once all eligible dwellings in SAP bands E, F and G had received measures, the eligibility was expanded to include all eligible households in D rated dwellings.

Table 2.2: Maximum spending caps used during the NHM modelling for dwellings receiving energy efficiency measures by energy efficiency band and for different annual scheme budgets

SAP band	£10m/£25m /£50m annual spend	£100 m annual spend	£10m/£25m /£50m annual spend	£100 m annual spend
	Mains gas heating		Non mains gas heating	
D	n/a	£4,000	n/a	£8,000
E	£4,000	£4,000	£8,000	£8,000
F,G	£5,000	£5,000	£12,000	£12,000

2.22 The NHM has the capability to model a range of energy efficiency retrofit measures including insulation, heating systems and low carbon technologies. Following consultation with the Welsh Government, the following list of measures were agreed upon as being the most suitable for an energy efficiency scheme in Wales:

- Loft insulation
- External wall insulation
- Cavity wall insulation
- Draught proofing
- Low energy lighting
- Mains gas condensing combination boiler (where a property already has a mains gas connection and the efficiency of the existing heating systems is less than 85 per cent)
- Oil condensing combination boiler (where a property already has an oil system and the efficiency of the existing boiler is less than 85 per cent)
- LPG condensing combination boiler (where a property already has an LPG system and the efficiency of the existing boiler is less than 85 per cent)
- Modern slim line fan assisted electric storage heaters (where property currently has old large storage heaters)

- Air source heat pumps (ASHP)
- Solar photo voltaic (PV) panels
- Solar thermal panels

2.23 In the modelling scenarios in each given year, houses were improved with the combination of measures which resulted in the biggest energy bill savings, whilst having capital costs below the spending caps. The scenarios continued installing measures in dwellings each year until the total cost of the measures had reached the annual budget allowance for that year. The scenario then moved on to the next year and began the process again until five years had elapsed.

2.24 Once a dwelling had received a measure then it was no longer eligible to receive any further measures in any future years of the five year scenario. In the £100 million budget scenario there was an exception to this; in this instance once all eligible households had received measures the eligibility criteria opened up to include dwellings rated with a SAP band D. It was possible that this meant that some properties which had already received measures (but still hadn't been improved above band D) became eligible for a second round of measures.

2.25 Each modelling scenario generates a report on all dwellings in the stock, documenting the changing circumstances of those households receiving measures. These outputs from the model form the basis of the results presented and analysed in Section 4.

3. Phase 1: Understanding, identifying and targeting households most vulnerable to living in cold homes

3.1 This section identifies, based on the result of the literature review, which groups the scheme should focus on, examining:

- The characteristics of households vulnerable to living in cold homes; and
- The definition of 'low income'.

3.2 Following these findings, the study then considers:

- How to define the target group;
- How to target eligible groups;
- How households could demonstrate eligibility for an energy efficiency scheme;
- How effective such eligibility criteria would be in allowing the scheme to reach the target group; and
- How the eligibility criteria could be refined to meet different scheme budgets.

Target households are those that we have identified as at high risk of living in cold homes and susceptible to the harmful effects from living in cold homes. These are the households that would be reached by the scheme in a perfect targeting situation as described in more detail in section 3 below.

Eligible households are those that meet the eligibility criteria recommended in Section 3, and are thus eligible for measures. Some vulnerable target households will not be reached using these eligibility criteria and a proportion of eligible households will not necessarily be 'vulnerable' or low income as discussed below.

Understanding the characteristics of households vulnerable to living in cold homes

- 3.3 A review of recent literature strongly suggests that living in a cold home can have significant adverse implications for a range of outcomes, including health, educational and social outcomes. Although anyone could potentially be affected by living in a cold home, the literature does identify associations between certain characteristics of individuals or households and:
- Having an above average likelihood of living in a cold home and/or
 - Being likely to be particularly vulnerable to the harmful effects of living in a cold home.
- 3.4 Several distinct characteristics were commonly reported as being disproportionately associated with vulnerability to the harmful effects of living in cold homes. This section presents a summary of the evidence, with a particular focus on identifying household-level vulnerability. There is evidence of a high degree of overlap between the reported household vulnerability characteristics i.e. a high likelihood households with one vulnerability will have multiple vulnerabilities. A full review of the literature can be found in Annex A on Page 94.

Older people

- 3.5 There are various reasons why older people have an above average risk of living in a cold home. One explanation is that elderly people are more likely to live alone, often in a large family home, and thus have high running costs that they must pay for from a single income (Goodman et al 2011, in Centre for Ageing Research and Development in Ireland, 2014). Older people who are no longer working are more likely to spend more of their time in the home, so may need to spend more of their income on heating to keep the house at a comfortable temperature. Amongst older generations, below-average rates of computer literacy and internet access and a lack of confidence in engaging with energy-related online services, such as online switching and tariff comparison sites, may partially explain why older

people are also less likely to be on lower tariffs (Tod et al, 2012, Stockton, 2014).

- 3.6 The literature specific to fuel poverty is relatively thin in its development of more social, attitudinal or behavioural explanations for why older people may be at greater risk of living in a cold home. These are likely to be important in understanding, for example, how attitudes to comfort, debt, investment in home improvement or availability of mortgage lending for older people may influence the fact that older people continue to live in poorly insulated homes that cost more to keep warm. One indication is from Tod et al 2012, which finds that 'factors usually associated with fuel poverty do not fully explain why some older people live in cold homes'.
- 3.7 As well as being more likely to live in cold homes, older people are more likely to be vulnerable to the harmful effects of living in cold homes. The vast majority of studies included in the NICE guidance evidence review identified greater winter- and cold-related mortality at older ages (NICE 2015). This is very clear in the numbers of excess winter deaths amongst older people in England and Wales. As reported in the NICE guideline, in 2013/14, 51 per cent of cold related deaths were among people aged 85 years and older and 27 per cent were among those aged between 75 and 84 years (NICE, 2015).
- 3.8 Physiological factors contribute to older people's greater susceptibility to the harmful effects of cold homes. These include a reduced ability to maintain their bodies at a stable temperature, age-related increased risk of heart attack, age-related increased susceptibility to cold-induced high blood pressure and the greater likelihood, with increasing age, of having pre-existing health conditions which are exacerbated by cold temperatures (Age UK, 2012; UK Health Forum, Friends of the Earth and the Energy Bill Revolution, 2013; Day and Hitchings, 2011; Marmot Review Team, 2011; Lacroix and Chaton, 2015).
- 3.9 Living in a cold home can also worsen social isolation amongst older people. Costly fuel bills make it harder to afford money to go out, and increase reluctance to risk getting cold going out and then having to go

back to a cold home. It can also deter older people from inviting friends around (Marmot Review Team, 2011).

Children – either aged less than 18 years or aged less than 5 years

- 3.10 There are an estimated 1.6 million children in the UK who are living in fuel poverty (ACE, 2013). Children living in certain household types are particularly at risk of living in cold homes, namely single parent households, low income households, households in rural areas, households headed by a black or minority ethnic parent and households headed by a parent with a long term health condition (National Children’s Bureau, 2012). Members of households with children, particularly children aged less than five years, spend an above-average amount of time at home, increasing their exposure to the harmful health effects of living in cold homes.
- 3.11 Physiological factors which contribute to children’s greater susceptibility to the harmful effects of cold homes include a lesser ability to deal with thermal stress as compared with adults, making children living in cold homes more prone to respiratory health problems, such as asthma and bronchitis (Marmot Review Team, 2011) (Climate Just, 2014). Weight gain in babies and toddlers can also be impeded by the increased calorie requirements to keep warm in a cold home. This can be particularly acute in materially deprived households with below-average calorie-intake (Liddell, 2008). Slow weight gain in the early years can lead to developmental disadvantages that persist into adult life. For school-aged children, there can be harmful consequences for educational attainment if school is missed due to cold home related illness (Liddell, 2008). A lack of a warm place to do homework may also cause children to fall behind in their studies (Marmot Review Team, 2011). Amongst adolescents, links have been drawn between mental health problems and time spent living in cold homes (Shelter, 2006); the reasons for this are not certain.

Disabled people and people with long term health conditions

- 3.12 The 2012 Hills Review of Fuel Poverty in England’ estimated that 34 per cent of fuel poor households include somebody with a disability or long

term health condition (CASE, 2012). Amongst disabled people, many struggle with paying their bills and keeping their homes warm enough (Gore and Parckar, 2009). Below-average employment rates amongst disabled people and associated below-average incomes mean that disabled people have a greater than average risk of living in a cold home (Disability Action, 2011).

- 3.13 Furthermore, high rates of unemployment amongst disabled people increase the likelihood of spending more time at home, and potentially in a cold home. Condition-related or impairment-related needs, such as muscular dystrophy, also explain why some disabled people or people with long term conditions spend greater than average time at home (Snell, Bevan and Thomson, 2013). Relatedly, disabled people with reduced mobility may suffer from reduced blood circulation, so that a higher-than-average temperature is needed to achieve a comfortable level of warmth in the home. It is well established that disabled people encounter increased costs to enable participation in everyday activities, whilst low incomes (associated with unemployment or low-paid employment) reduce the ability of households to afford energy bills (Disability Action, 2011; Gore and Parckar, 2009; George, Graham and Lennard, 2013).
- 3.14 For people living with certain long term conditions, living in a cold home may aggravate their condition and/or hinder their recovery (Bevan Foundation, 2010). The literature identifies respiratory diseases, chronic obstructive pulmonary disease (COPD) and circulatory diseases as being the most likely to be aggravated by living in a cold home (WHO, 2011; Lacroix and Chaton, 2015; Webb et al., 2013; Canterbury District Health Board, NZ, 2012; Lacroix and Chaton, 2015; Public Health England, 2014).

Mental health

- 3.15 People living with mental health conditions are disproportionately on a low income, placing them at increased risk of being unable to afford to heat their homes adequately. Some studies also indicate that individuals with mental health conditions are more likely to subjectively perceive their home as too cold (Threlfall, 2011).

- 3.16 There are a number of studies and reviews that identify associations between cold homes and mental health problems, with consequent harmful social costs such as the cost of mental health problems to the NHS or the loss of well-being (EAGA Charitable Trust, 2010; Stafford, 2015). Living in a cold home is a distressing experience that may combine physical discomfort with financial worries about the ability to pay fuel bills. A Scottish study has shown that those struggling to pay their utility bills are four times more likely to be anxious and depressed than those with no such difficulties (Scottish Government, 2012). A coping strategy of just heating a small number of rooms can give rise to overcrowding, strained social relationships and feelings of shame associated both with the circumstances and with the inability to offer hospitality (Environment Canterbury, 2013).

Those paying for their fuel with a pre-payment meter

- 3.17 Households that pay for their fuel using a pre-payment meter (PPM) were identified to be twice as likely as other customers to be unable to afford to heat their home adequately (Christians Against Poverty, 2015).
- 3.18 PPM customers are more likely than customers using other payment methods to be on a low income (Vyas, 2014), whilst also being more likely to be on more expensive tariffs. A recent review by Citizens Advice highlighted that the average annual PPM tariff was £226 more expensive, on average, than the cheapest online direct debit deal and £80 more expensive than the average annual energy bill of direct debit customers (Citizens Advice, 2015).
- 3.19 As a result, those on pre-payment meters are likely to be particularly exposed to the choice about whether to spend their limited income on heating their home or on other essentials such as rent, food or council tax. Christians Against Poverty's 2015 survey highlighted that over half of all pre-payment users ration their own energy usage to at least some extent. It also highlighted associated issues with borrowing from costly credit sources and above average risks of rent arrears and problems with other bill payments.

- 3.20 Certain other characteristics identified as ‘vulnerability markers’ are also associated with use of pre-payment meters. These included lone parent households, individuals with mental health conditions, individuals with learning difficulties and people with physical health problems. The Christians Against Poverty report identified that two thirds of pre-payment meter customers had ‘at least one key support issue’, meaning a characteristic or condition that is a possible marker of needing support with the effects of a cold home.
- 3.21 Prepayment meter customers are not a homogeneous group of households, but there is evidence that highlights the difficulty of people paying for their energy through this method. While the priority of an energy efficiency scheme is primarily about improving the thermal performance of homes, it should be recognised that prepayment households exhibit a number of vulnerable characteristics, and tend to be low income. As such, it is expected that they will be picked up through the prioritisation of vulnerable households on low incomes.

Households living in inefficient housing

- 3.22 Energy inefficient homes are typically those with poor levels of insulation or inefficient heating systems. The energy performance or energy efficiency of a home is measured using ‘SAP’, which is explained in more detail in Paragraph 3.47 on Page 27.
- 3.23 In addition, homes heated by fuels such as oil, LPG or electricity are often referred to as ‘hard-to-heat’ homes because these are more expensive fuels which can result in higher energy bills than similar homes heated by cheaper fuels such as mains gas. Older dwellings constructed using solid brick or solid stone are also known as ‘hard-to-heat’ because these walls conduct heat out of the dwelling more quickly than homes built with cavity walls or more modern construction techniques.
- 3.24 When referring to ‘cold homes’, we are typically referring both to energy inefficient and to ‘hard-to-heat’ dwellings.

The definition of low income

- 3.25 This Report is particularly concerned with those households living on low incomes. It should be stated that the vulnerabilities identified above do arise amongst all levels of household income. However, as noted above, there are strong inter-relations between low income status and certain vulnerable characteristics, for example, disability.
- 3.26 Low income households are of interest for a number of reasons relevant to energy efficiency programme design. They have, by definition, limited financial means to be able to heat their homes to adequate levels of warmth in cold winters (Centre for Sustainable Energy, 2010). Low income households may come up against a “heat or eat” dilemma whereby they have to make a decision between heating their home and buying food (Marmot Review Team, 2011). The limited financial means of low income households also reduces their ability to pay for energy efficiency improvements to their homes, in order to make them easier to heat and cheaper to run.
- 3.27 Specific factors, such as the existence of debts or unemployment, have also been independently linked to the likelihood of living in a cold home (Public Health Policy Centre, 2007; Bouzarovski, 2014).

Defining low income

- 3.28 The definition of low income is not a fixed one and various measures of low income have been adopted over time and in different countries. Commonly in the UK, the standard definition of low income specifies that households on an income below 60 per cent of the national median income are on low incomes (or in relative poverty). In this definition, incomes are equivalised for different household types and can be expressed either ‘before housing costs’ (e.g. rental or mortgage payments) or ‘after housing costs.’
- 3.29 The median income is favoured over the mean, which was used previously, due to the fact it is not skewed by households with very high or very low outlying incomes. For example, a change in the income of only those at the

very top or the very bottom of the income scale will not result in any change in the median, unlike the mean which would move in response.

- 3.30 Low income may be classed as either absolute or relative. A household is considered to have relative low income if they earn less than 60 per cent of the median income for the present year. For the Households Below Average Income series, absolute low income is any household with an income of less than 60 per cent of the median income in 2010/2011.³ This definition of absolute low income is also the one that is used for the Child Poverty Act 2010.
- 3.31 For these definitions, the composition of a household is considered to have an impact on the amount of income they require. Incomes are adjusted for different needs on the principle that the same income will stretch further in a smaller family than a larger one, a process known as equivalisation. An adult couple with no children is taken as the reference point, and the low income thresholds for households of different compositions are equivalised using different factors.
- 3.32 In this Study, the relative low income definition was chosen as it aligns with the current method of measuring poverty. The median income for Wales was determined from the 'Households Below Average Income' (HBAI) dataset⁴. Data is available in the HBAI for income both after housing costs (AHC) and before housing costs (BHC). In this Study, we have based low income calculations on before housing costs income. This is due to several factors, with a key consideration being the fact that potential recipients need to be able to demonstrate their eligibility simply and easily when applying for the scheme. Determining low income status through the BHC indicator only requires knowledge of income levels, which in most cases will be present on a proof of benefit letter. Calculating AHC income requires

³ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/432843/hbai-low-income-how-is-it-measured-infographic.pdf

⁴ The HBAI data is based upon findings from the Family Resources Survey (FRS) which collects information about the income and circumstances of British families. The survey usually reaches around 20,000 households.

additional information about housing costs which may be more difficult to prove, be less reliable and make the process more complex.

3.33 In Wales in 2013/14 the median weekly BHC income was £422, which equates to a median annual household income of £22,019. This gives a relative low income threshold (60 per cent of the median) of £13,212 for a couple with no children.

3.34 The population was subdivided into six different household types, each with their own relative low income threshold taking into account the household composition i.e. the number of adults and whether there are children in the household. In order to simplify the standard equivalisation process whilst providing an appropriate level of differentiation, a maximum of six groups were used⁵. The groups and thresholds are shown below in Table 3.3.

3.35 In the remainder of the report, households on incomes below the 60% median thresholds are referred to as '**households on incomes below the income threshold**' or as being households with a '**relative low income**'. The phases are used interchangeably in the report.

Table 3.3: Relative low income thresholds for different household types in Wales (before housing costs)

Household composition	Weekly income threshold	Annual income threshold
'Single adult'	£170	£8,845
'Single adult with children'	£271	£14,125
'Couple'	£253	£13,201
'Couple with children'	£354	£18,482
'Multiple adults'	£336	£17,558
'Multiple adults with children'	£438	£22,838
All households	£253	£13,212

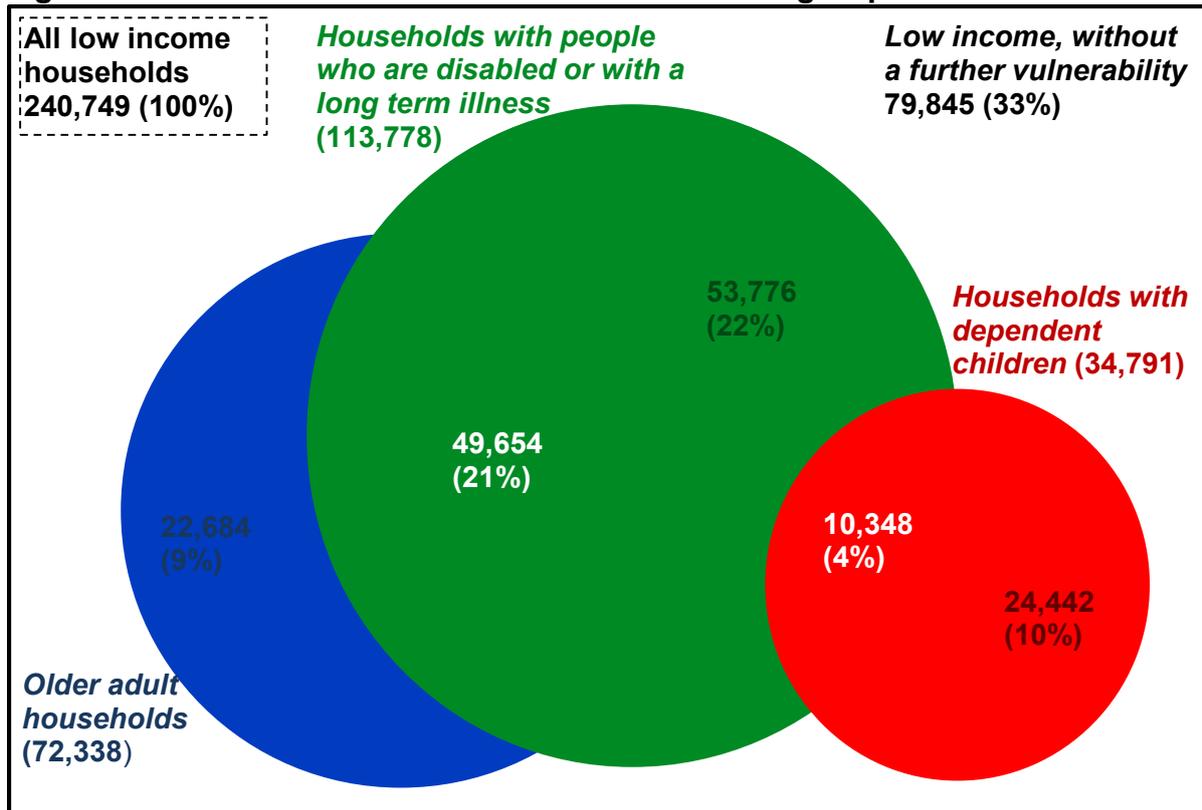
Source: Households Below Average Income 2014-15 dataset

⁵ Further information on the equivalisation process is available in the Government guidance publication 'How low income is measured in households below average income statistics', available here: <https://www.gov.uk/government/publications/how-low-income-is-measured>

Low income households with multiple vulnerabilities

- 3.36 Low income households with multiple vulnerabilities are likely to be particularly at risk of living in cold homes and of being vulnerable to the harmful effects of cold homes. They contain either people who fall into two or more different vulnerable categories or contain more than one individual with at least one vulnerable condition.
- 3.37 Analysis of the Living in Wales survey 2008 has been used to estimate the proportion of low income households who also have a vulnerability. This analysis shows that a significant proportion of low income households have dual markers of vulnerability to the harmful effects of cold homes, including:
- Older people who have a long term illness or disability; and
 - Households with children, which also include a household member with a long term illness, health condition or disability.
- 3.38 Households including both an older household member and at least one person with a long term illness or disability account for an estimated 21 per cent (49,654) of all low income households in Wales.
- 3.39 Approximately one third of all low income households with children are also estimated to include at least one household member with a long term illness or disability.

Figure 3.1: Low income households and vulnerable groups



Source: Living in Wales Survey 2008 (percentages may not sum to 100 per cent due to rounding)

Defining the target group

3.40 Based upon the findings of the literature review and data analysis, and through discussions with Welsh Government, it was decided that the target group to receive assistance through a future home energy efficiency scheme should be any household which met all four of the following characteristics:

- Living in a home that is owner occupied or privately rented;
- In a home that is energy inefficient
- On a relatively low income; and
- With an additional vulnerability (as identified through the literature review).

The following sections summarise the Authors' recommendations as to how each of the above characteristics should be defined:

Tenure

3.41 As noted above, the Welsh Government specified when commissioning this Report that any future scheme should target households living in **private rented** or **owner occupied** dwellings. Given that socially rented properties tend to be more energy efficient than private housing, the authors concur with this recommendation.

Energy Efficiency

3.42 It is recommended that homes with **SAP ratings of E, F or G** are defined as being energy inefficient and are targeted in future schemes. However, if a budget of £100 million or higher is available, it is recommended that **the criteria are widened to include properties rated D,**

Low income households

3.43 It is recommended that low income should be defined as a before housing costs income **below 60% of the median income** in Wales – this is a relative measure of low income.

Vulnerable households

- 3.44 It is recommended that future schemes look to target low income households with the following additional vulnerability characteristics:
- Households containing **older adults** (all households containing people aged 65 years and over to be eligible but recognising, where the scheme budget is below £10 million, that those **aged 75 years or over** are likely to be the most vulnerable of this group);
 - Households which include **dependent children** (under 18 years, but recognising, where the scheme budget is below £10 million, that **children aged under five years** are particularly vulnerable);
 - Households which include at least one person with a **disability or long term health condition**;
 - Households which include at least one person with a **respiratory or circulatory disease**; or
 - Households which include at least one person with a **mental health problem**.
- 3.45 With regard to mental health problems, there are various potentially significant challenges associated with targeting people with this additional vulnerability. These include the fact that a broad range of mental health problems exist and they vary in terms of both severity and duration so that some additional thought will need to be put into deciding which conditions and of what duration should qualify. The evidence presented above in Paragraph 3.15 and in Annex A suggests that those suffering with mental health problems – as a broad category - should be considered a vulnerable group who are negatively affected by living in a cold home. However, there is less clear evidence about the most appropriate way to target this group, and about which mental health conditions in particular are the most affected. Further thought will also be needed in order to design a scheme that engages appropriately with people with mental health problems, being

sensitive and taking particular care when assisting them through the process of demonstrating their eligibility and through the installation process. It is recommended that further work should explore innovative ideas in this area, to establish best practice and effective ways to engage and target people with mental health problems. This is likely to require, amongst other approaches, involvement and consultation with key experts, patient groups and practitioners in this field.

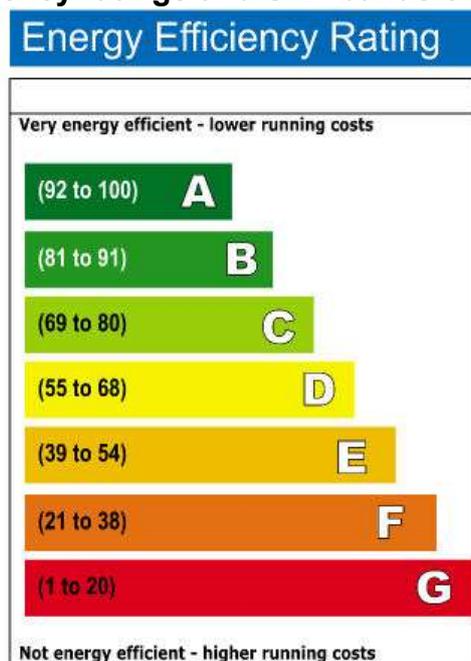
- 3.46 Since further work is needed to identify precisely which mental health conditions and of what duration might allow an individual to qualify to receive measures, any estimates based on all individuals reporting any form of mental health problem would significantly overestimate the numbers of dwellings that would become eligible. People with mental health problems have therefore been excluded from the tables reported in this Section.

Energy Inefficient properties

- 3.47 It was identified that an important risk factor for living in a cold home is the energy efficiency of dwellings. In the UK, the efficiency of dwellings is usually measured by the Standard Assessment Procedure (SAP) developed by the Building Research Establishment (BRE) in 1992 and used to assess and compare the energy and environmental performance of dwellings. SAP assessments are used to award EPCs to homes, which include a SAP score between 1 and 100, a low score indicating an inefficient dwelling and a high score representing a high efficiency. SAP scores are used to allocated SAP bands to dwelling between A and G, with A being the most efficient band and G being the least efficient⁶ (Figure 3.2).

⁶ www.gov.uk/guidance/standard-assessment-procedure

Figure 3.2: Energy efficiency ratings and SAP bands of dwellings



- 3.48 Currently, energy efficiency improvements are available under Warm Homes NEST to qualifying households who inhabit homes **with SAP ratings of E, F or G**; only the most inefficient homes with a SAP rating below 54 are targeted. Many F and G rated homes have been improved in recent years and the majority of homes in this group of dwellings are rated E. Measuring the efficiency of homes using SAP ratings is a commonly understood and widely used system, and it is recommended that the same group of inefficient properties (bands E, F and G) is targeted in future schemes where budgets below £100 M are available.
- 3.49 However, where higher budgets were available, it is recommended that Welsh Government to **expand the criteria to include properties rated D**, to provide assistance to a wider target group. While properties rated D are relatively more efficient than E, F and G rated dwellings, significant cost-effective improvements can still be made to many of these homes, further reducing the vulnerability of people to living in cold homes.
- 3.50 In order to ensure that only the most inefficient homes receive measures, it is recommended that the scheme completes energy assessments on applicants' homes to confirm their Sap rating before measures are installed.

Tenure

- 3.51 It was identified that the scheme should target households living in **private rented** or **owner occupied** dwellings. Socially rented properties tend to be more energy efficient than private housing; local authorities and housing associations also have existing funding streams to improve this type of housing. Although low income households live in social housing, therefore, they are less likely to be at risk from being in cold homes.

Processes for households to demonstrate eligibility

- 3.52 A key part of a future scheme will be to consider the means by which households will be able to demonstrate their eligibility, once they have been located and/or have approached the scheme.
- 3.53 The main way that households will be able to demonstrate eligibility due to low income is through proof of benefit correspondence from HMRC/DWP.

Existing means tested income-related benefits

- 3.54 Means tested benefits have been used to identify low income and vulnerable households for a series of energy efficiency schemes in the UK over the last decade (for example, Warm Front, Carbon Emissions Reduction Target (CERT) and ECO), and are currently used by the Nest scheme. As these systems are now well established, for the foreseeable future it is recommended that the use of means tested benefits continue to be used as part of a satisfactory and workable solution for households to demonstrate eligibility⁷.
- 3.55 Means tested benefits are claimed by a significant proportion of low income vulnerable households. Being eligible for these benefits usually means that recipients have been through a series of checks, including reviews of their incomes and savings. Therefore, demonstrating receipt of these benefits is,

⁷ Several previous studies have found that there is not a particularly good match between households in receipt of means tested benefits and those who are in fuel poverty, according to the 10 per cent definition (for example, Scottish Government, 2012). However, the purpose of this study is not specifically concerned with targeting fuel poor households per se, but with better targeting the scheme to reach those low income households most at risk from living in cold homes, who could particularly benefit from this type of scheme.

in many cases, a good indicator of having a low income and, for some benefits, of having an additional vulnerability. In addition, proving that they are in receipt of means tested benefits is a relatively easy way for these households to demonstrate their eligibility. People claiming means tested benefits are often familiar with requirements of producing paperwork to access a range of specific services⁸. Furthermore, this paperwork can include additional details such as whether the claimant is receiving disability aspects of certain benefits or whether they are responsible for children.

3.56 The following list of benefits is considered the most appropriate set of existing means tested benefits:

- **Pension Credit** (Guarantee Credit Element), which covers low income older people
- **Child Tax Credit** and with income below a certain threshold, which captures low income households with dependent children
- Income related **Jobseekers Allowance** and **Child Benefit**, which includes other low income households with dependent children
- Income related Employment Support Allowance (ESA), identifying low income households with additional vulnerabilities
- Benefits that were replaced by ESA (**Incapacity Benefit**, **Income Support** paid because of illness or disability, **Severe Disablement Allowance** (SDA)), which covers some low income disabled people
- **Income support**, for which low income and pregnant mothers, carers, lone parents with a child under 5, or long sick or disabled are all eligible.
- **Universal Credit** (combines six existing benefits into one: Income Support; income related Job Seekers Allowance; income related Employment Support Allowance; Child Tax Credits; Working Tax Credits; and Housing Benefit)

⁸ Experience of front line advice workers in CSE's Household Energy Services (HES) team

- 3.57 In combination, this list would enable the identification of households with most of the identified markers of vulnerability. The majority of recipients of these benefits will have many of the characteristics identified as being vulnerable earlier in this section and will, on the whole, be on comparably low incomes compared with the rest of the population of Wales. However, not all recipients will be on incomes below the relative low income threshold as most of these benefits can only be used as a proxy for low income. Some of the issues raised in this Section are explored further within the relevant targeting system options in the following Section.
- 3.58 Qualifying households will also need to demonstrate the age of an inhabitant matches the criteria. This can be simply done with commonly held documents showing proof of address and age, such as utility bills, passports, driving licenses.

Which targeting system should the scheme use?

- 3.59 As noted by many commentators (Legovini, 1999; Dubois, 2012), identifying and targeting a specific section of the population is a complex undertaking. It is almost certainly impossible to produce a 'perfect targeting' approach. In general, there are two main targeting errors associated with using proxies to identify a group of households (Legovini, 1999). A 'targeting efficiency' error involves excluding people who should be included, whereas a 'leakage' error involves including people who should be excluded. Another key consideration is the administrative cost of targeting. In general, most schemes seek to ensure that leakage is minimised without incurring excessive administrative costs.
- 3.60 An optimal targeting system is one which can identify and engage low income households with additional vulnerability characteristics, but which does not incur unreasonable costs. There are several options for achieving this, all of which have implications in terms of the choice of eligibility criteria, the means of engaging with qualifying households, and the wider promotion and marketing of the scheme. The five main options identified by this Study are considered below.

Option 1 Households identified through data matching of housing and income data

- 3.61 One option would be to use an automated data matching process that makes use of both housing and income data. A recent UK government consultation – ‘Better use of data in government’⁹ – proposed a specific data matching arrangement to assist citizens living in fuel poverty. It recognises that various government datasets exist on income and dwelling characteristics that could ‘enable the coldest homes to be identified without the need for expensive and intrusive on-site surveys’.
- 3.62 It is likely that such a process would be a UK-wide operation with information held by a government funded and regulated third party organisation. This body could act as a central data repository. The data held could include address level information on housing from sources such as the UK Government’s Department for Communities and Local Government (DCLG) and the Department of Energy and Climate Change (DECC), the Valuation Office Agency (VOA) and from Energy Performance Certificate (EPC) records. Income data could be provided by the Department of Work and Pensions (DWP) or HM Revenues and Customs (HMRC).
- 3.63 Once established, administrators for an energy efficiency scheme in Wales could request address level information for all households meeting certain criteria. For instance, those in housing with particular efficiency levels containing individuals with an income below a certain threshold and with other specific housing or household characteristics. The central data body would not need to supply any personal or sensitive information, and the address level data could be used as a basis for marketing the scheme and targeting households.
- 3.64 CSE staff have met with personnel from DECC and it is understood that the department is currently pursuing the option of developing such a system.

⁹ <https://www.gov.uk/government/consultations/better-use-of-data-in-government>

This is likely to build on the automated data matching processes established to award Warm Homes Discount payments to the core group.

- 3.65 One advantage of data matching is that this bypasses the need for households to demonstrate their eligibility, as the data held about them e.g. by the benefits agency, is used to determine eligibility. However, as discussed above, this is unlikely to be a practical option in the near future.
- 3.66 There are a number of considerations required of such a complex approach, and the research here will not explore these in depth. However, it is worth noting that such a system would require a clear opt-out process for all households and would have to adhere to rigorous data protection protocols. It is unlikely that this will be commissioned within the timescales being considered for a new national energy efficiency scheme in Wales, and so is unlikely to be a solution in the short term. However, such an option is likely to be worth considering in the future.

Option 2 Self-qualification with partial, retrospective verification

- 3.67 The smallest administrative burden possible – and therefore the lowest cost option - would be achieved by allowing applicants to self-affirm their eligibility. This system would allow eligible individuals to contact the scheme directly, explaining how they meet the eligibility criteria but would only confirm eligibility retrospectively for a random sample of recipients rather than requiring up-front proof of eligibility.
- 3.68 This approach is not a new proposition; versions of self-qualification existed within CERT and currently operate for the Warm Home Discount (WHD) broader group.
- 3.69 There are several benefits associated with a self-referral approach. Compared with setting up a new means testing process, a self-qualification process is relatively simple, which implies that it would be less costly, depending on the size of the scheme and the number of applications being processed. This in turn could allow more funding to be spent on the installation of improvement measures and ensure more households directly benefit from the scheme.

- 3.70 If any applications were found to be fraudulent then actions could be applied retrospectively, such as recovering the cost of installation works. Information could be provided about potential sanctions when households applied to the scheme and could serve as a deterrent to false self-affirmations of eligibility. In practice, attempting to recover fraudulently claimed funding is likely to be an impractical and prohibitively costly option, requiring lawyers and legal support.
- 3.71 However, one concern with a self-qualification system is that it does not necessarily require a detailed demonstration of eligibility. Some level of information would always need to be provided, and this could include age information, tenancy details, National Insurance number or NHS number. It remains to be seen whether such a scheme would make it possible to provide measures to members of the target group who would be otherwise hard to reach, for example people who are not in receipt of benefits (whether entitled to them or not), but who are still on low incomes.
- 3.72 However, a future energy efficiency scheme for Wales will need to have assurance that it is reaching vulnerable households, a certainty that can only arise through people demonstrating their eligibility (or from confidence in third parties' ability to identify or select vulnerable households). Further, it is a requirement of the Welsh Government that an applicant's eligibility can be demonstrated in practice to the scheme manager. Therefore a self-qualification system is not considered appropriate for a national scheme.

Option 3 Self-affirmation with verification

- 3.73 A system that builds on the self-qualification system described above is one where potential recipients are still able to contact the scheme directly but where verification of eligibility is completed before measures are provided. In cases where demonstrating eligibility is a relatively simple matter, this could be completed directly by scheme representatives. Simple cases would be those involving only eligibility based on the following:
- low income (receipt of a means tested benefit);

- disability (where it can be verified by receipt of a disability-related benefit); and
- where relevant, the age of household members.

3.74 Cases with eligibility criteria that are more complex to verify i.e. individuals with respiratory, circulatory or mental health conditions or those on low incomes but not in receipt of means tested benefits, could be referred by the scheme to third party referral organisations who would complete the verification process or require the applicant to gain the support of a health professional. For example, in order to target low income people with certain health conditions, the third party referral organisation could request both an NHS number and a National Insurance number and details of their medical situation.

3.75 However, requiring a letter of support from a health professional confirming the applicant's medical situation would represent an unacceptable burden on the NHS. This may require people booking appointments and GPs may charge for this (previous experience from front line CSE staff suggests that these costs could range from around £25 to £125). This would put additional pressure on GP appointment waiting lists and many applicants could be waiting weeks for such an appointment. This process could also increase the level of stress for the most vulnerable people, and require additional support from scheme administrators to guide and reassure them through the process.

3.76 The verification of eligibility also requires the disclosure of sensitive personal information, which could deter some applicants, for the same reasons people choose not to apply for means tested benefits.

3.77 It is further recommended that people on relative low incomes who have certain health conditions but are not receiving any of the qualifying benefits are able to be referred to the scheme through a third party organisation. Under this option, third party organisations and/or potentially the NHS could also be allowed to refer individuals to the scheme. It should be noted that some existing third party referral organisations may not be equipped to

verify the full range of health conditions under consideration as eligibility criteria. Further, if third party organisations are being resourced to fulfil this role for some scheme applicants, it may make better financial and practical sense for them to administer the scheme in its entirety.

- 3.78 This is an option Welsh Government may wish to consider further as part of the design of a future scheme.

Option 4 The use of third party referral organisations

- 3.79 A further approach could be a system that exclusively uses third party agencies to perform the referral process. These agencies would be commissioned by the scheme administrators and be required to undertake a referral pre-accreditation process. The energy efficiency scheme could award funding to pay for agencies to develop a referral mechanism and invite agencies to bid for this funding. In return, an agreement between scheme administrators and referral agencies would likely include a commitment to refer a certain number of households to the scheme. The scheme itself could include ongoing support to help cover the administrative costs incurred by agencies in making referrals, which could be tailored to suit the size and existing infrastructure of different organisations.

- 3.80 Referral via third party organisations is likely to be a workable and successful option and is considered a practical and feasible option for reaching people with the health conditions identified above.

- 3.81 As concluded in the recent evaluation, the processes used by the Warm Homes NEST scheme to allow households to demonstrate their eligibility through being on means tested benefits is a reasonably accurate system (Welsh Government, 2015). However, it has been recommended (see above, Paragraph 3.44) that, for any future scheme, all households on relative low incomes and that include a member with a respiratory, circulatory or mental health condition should be considered eligible. The use of a third party referral system would also help to ensure that those

who aren't on benefits but who have other qualifying vulnerabilities can still benefit from the scheme. In light of changes to the welfare system, it is particularly important to consider including the use of third party referral agencies in the administration of any future scheme.

3.82 Agencies and bodies likely to be able to help with outreach or to act as third party pre-credited referral agencies include the following:

- Care and Repair or equivalent service
- Local authorities
- Condition, age related or child support charities (e.g. MIND, Age Cymru, Royal Volunteer Service, Bernardo's) and particularly those charities doing outreach work or working directly with vulnerable people
- Agencies providing support and services under 'direct payments for community care'.
- Adult social care providers (either local authority departments or partner organisations contracted to deliver these services)
- Community care services providing care to patients in their own homes

3.83 These agencies' primary roles are to help their clients with various social needs, towards better wellbeing and other positive outcomes. A third party agency approach would involve initial expenditure in the setup of a referral system and ongoing costs to make these referrals. It would also require agency staff to develop their awareness about vulnerability to cold homes, which may require them to adapt their approach to engaging with clients beyond their existing areas of support and advice. However, agencies are likely to recognise the potential benefits for the wellbeing of their clients and are likely to be interested in being involved, where the scheme is in line with their organisational purpose and approach.

3.84 The additional advantages of a third party referral system would be the ability of these agencies to use their existing knowledge and judgement to

refer households or individuals to the scheme. It is also likely to be a relatively cost effective method of identifying people in the appropriate target groups, since such agencies are likely to have existing experience in identifying and engaging with such households and individuals.

3.85 The advantage of a referral system using third party approved organisations is that it does not restrict eligibility to just those households in receipt of specific means tested benefits. However, that does not exclude the requirement that referral organisations provide assurances of eligibility. In the case of third party referral organisations, we are primarily looking for referrals of households who are below the income threshold and who also include household members who have a respiratory, circulatory or mental health condition. Income may be more difficult to evidence in this case, and would require third party agencies to have prior knowledge of the income status of households or have a strong and trustworthy relationship with their service users in order to obtain this sensitive information. For example, such a process may be through a check of payslips or P60 forms from employers. The specific income details of the household would not need to be shared with a scheme manager, but the organisation would be required to perform a check to ensure that the household was below the low income threshold, and to make guarantees to the scheme administrators that these had taken place.

3.86 However, it should be recognised that this approach of using a system that uses such third party agencies is unlikely to engage with and reach all vulnerable households, for example those who have minimal engagement with agencies.

Option 5 New means tested approach

3.87 In theory, it would be possible to develop and oversee a new assessment approach based on means testing specifically serving an energy efficiency scheme. This would be along the lines of existing national means testing procedures administered for various financial assistance schemes. It would

require people to provide information about their income and other circumstances in order to demonstrate eligibility to benefit from the scheme, and for a series of checks to be performed on this information. While this could minimise leakage, it is likely that this would be a very costly exercise, diverting significant amounts of finance from the grant pot and thus impacting on the number of people receiving assistance through the scheme.

- 3.88 There are, however, some disadvantages of creating a new means testing process. For example, it should be recognised that individuals can find means-testing stressful and feel anxious about it. Certain households and individuals may find it particularly hard to locate the relevant paperwork or feel uncomfortable answering questions about their situation. Furthermore, it is difficult to conclude that a means testing based approach is a wholly satisfactory method of reaching all the households that are most at risk of living in cold homes. The take-up rate for benefits is not 100 per cent and there will thus be a number of households who are not receiving the benefits they are entitled to and who will not be reached via this method. Finally, recent welfare reforms and work capability assessments have led to a reduction in the numbers of potentially eligible people claiming certain benefits (Work and Pensions Committee, 2014). Relying solely on eligibility criteria based on existing receipt of benefits could perpetuate the exclusion of such households from receiving assistance. It is therefore recommended that in addition to using means tested benefits as a way for households to demonstrate eligibility, alternative methods of allowing vulnerable households to qualify are considered.

Targeting efficiency

- 3.89 A summary of the proposed routes for qualifying for a future scheme is presented below in Table 3.4, providing a summary of how different vulnerable groups could demonstrate eligibility for the scheme. A discussion of the targeting efficiency of this proposal follows. It should be noted that, in most cases, the method used to demonstrate eligibility will be the same whether potential recipients self-affirm their eligibility or are

referred by third party agencies. For the vulnerabilities of respiratory, circulatory or mental health conditions the only practical method for scheme managers to assure themselves that a household is eligible would be for them to be referred by a third-party agency. It should also be noted that, as discussed above, some households on qualifying means tested benefits will be on incomes slightly above the 60% low income threshold, and therefore are not specifically in the target group. These groups are discussed further below.

Table 3.4: Summary of ways to demonstrate eligibility for main types of vulnerable household

Vulnerable household type	Main way to demonstrate eligibility for scheme
Households which include a person with a disability or who has a long term limiting illness	Demonstrating receipt of means tested benefits (e.g. ESA, Incapacity Benefit, Income Support paid because of illness or disability, Severe Disablement Allowance)
Households which include a person over 65 years	Demonstrating receipt of means tested benefits (e.g., Pension Credit)
Households which include dependent children aged 18 years or under	Demonstrating receipt of means tested benefits (e.g. Child Tax Credit and below income threshold, Jobseekers Allowance and receipt of Child Benefit)
Household income below 60% median, and which include someone with respiratory, circulatory or mental health condition	Referral through third party agencies

3.90 Table 3.5, below, shows the numbers and proportion of the target group (low income vulnerable households) who are estimated to be eligible for the scheme using the eligibility criteria outlined above. The table also shows the estimated numbers of households who are eligible for the scheme due to being in receipt of means tested benefits but who are not in the target group because they are not on a relative low income. For all budget scenarios, it is assumed that those low income households that include a member with a disability or long term limiting illness are captured by the means tested benefits specified in Paragraph 3.73. Overall, the leakage rate – or proportion of people who are not in the target group but who are

eligible for the scheme due to receiving means tested benefits – is between 15 and 19 per cent.

- 3.91 Table 3.6 below, (reproduced from IPPR, 2013), provides an estimate of the targeting efficiency of various recent UK schemes. With the exception of the amended Warm Front programme in 2011, it is estimated that fuel poor households (i.e. the ‘target group’) comprised between 19 and 37 per cent of eligible households. While these schemes vary, many are designed to help reduce fuel poverty. The targeting efficiency rate of between 75 and 81 per cent estimated for a scheme with the eligibility criteria recommended here therefore compares favourably with other national schemes.
- 3.92 As the statistics in Table 3.7, below, show, the majority of households who are eligible for the scheme due to receiving means tested benefits but who are not on a low income are eligible due to being in receipt of Incapacity Benefit, Income Support or Pension Credit. It is worth noting that Incapacity Benefit has now been replaced with Employment and Support Allowance (ESA) and, in turn, will eventually be replaced by Universal Credit; it is currently unclear how these changes would impact a future scheme.
- 3.93 However, Table 3.9 also demonstrates that those who are eligible for the scheme but not on a low income, are still generally on incomes close to the low income threshold. For eligible households with an income **above** the low income threshold, the median income is estimated to be £19,207. This compares with an estimated median income of £10,631 for eligible households with an income **below** the threshold and £27,464 for households that are not eligible for the scheme (as shown in Table 3.10).
- 3.94 The eligibility criteria described above in Table 3.4 would also be estimated to result in some 4,128 households receiving measures who are on a low income but who do not have any of the additional vulnerabilities identified in the evidence assessment. However, as Table 3.9, below, shows, the median income for this ‘low income only’ group, at £8,262, is the lowest of all the eligible groups. For the purposes of this report, vulnerability from living in cold homes is about more than just being on a low income. However, these ‘low income only’ households who qualify for the scheme

through being in receipt of means tested benefits are on some of the lowest incomes in Wales. Allowing these households to be eligible should perhaps therefore not be considered a significant disadvantage.

Table 3.5 Household types qualifying for energy efficiency measures under the proposed eligibility criteria

Household type	Dwellings in SAP bands E, F or G (SAP < 54)		Dwellings in SAP bands D, E, F or G (SAP < 68)	
	Number eligible for scheme	Proportion of all eligible hhlds	Number eligible for scheme	Proportion of all eligible hhlds
Income above 60% median <i>(qualifying through being on means tested benefits)</i>	12,934	19%	16,245	15%
Income below 60% median, but no additional vulnerabilities <i>(qualifying through being on means tested benefits)</i>	4,128	6%	4,568	4%
Income below 60% median, with disabled or long term sick person	7,461	11%	10,259	9%
Income below 60% median, with person over 65 years	9,952	15%	12,661	11%
Income below 60% median, with people over 65 years and disabled or long term sick	15,539	23%	33,339	30%
Income below 60% median, with dependent children	7,398	11%	19,239	17%
Income below 60% median, with dependent children and disabled or long term sick household member (child or adult)	10,726	16%	15,447	14%
All qualifying households	68,139	100%	111,758	100%

Source: Modelled Wales Housing Stock constructed for the NHM by CSE using the EHS 2012 and the LiW survey 2008.

Table 3.6 The targeting efficiency of recent energy efficiency schemes

Scheme	Percentage of eligible group estimated to be fuel poor
CERT priority group	25.2%
CERT super priority group	27.4%
CESP	22.4%
Warm Front pre-2011	30.3%
Warm Front 2011 onwards	68.8%
Winter Fuel Payments	19.0%
Cold Weather Payments	20.0%
Warm Home Discount	28.0%
ECO HHCRO	37.2%
ECO CSCO	26.9%

Source: IPPR, 2013

Table 3.7 Number of households by qualifying benefit or condition and by household type for private rented or owner occupied dwellings in SAP bands E, F or G (SAP rating < 54) ^a

Qualifying benefit or condition	Target group:		Eligible by not in target group (in receipt of means tested benefits)			Total households
	Below income threshold, vulnerable, on MTBs	Below income threshold, vulnerable, not on MTBs	Below income threshold, not vulnerable, on MTBs	Above income threshold, vulnerable, on MTBs	Above income threshold, not vulnerable, on MTBs	
Pension Credit	23,665	0	825	2,410	368	27,268
Income ESA	3,472	0	0	0	0	3,472
Incapacity Benefit	5,512	0	890	7,541	0	13,943
Severe Disablement Allowance	0	0	0	0	0	0
Income Support	4,666	0	0	2,310	341	7,317
JSA income	4,400	0	1,816	87	0	6,303
Child Tax Credit (and income below threshold)	7,659	0	0	0	0	7,659
Respiratory illness (and income below threshold)	2,962	2,438	0	0	0	5,400
Circulatory illness (and income below threshold)	2,745	1,109	0	0	0	3,853

Source: Modelled Wales Housing Stock constructed for the NHM by CSE using the EHS 2012 and the LiW survey 2008.

^a Households can be in receipt of more than one qualifying benefit or condition so numbers in groups do not sum to totals shown in other tables.

Table 3.8 Number of households by qualifying benefit or condition and by household type for private rented or owner occupied dwellings in SAP bands D, E, F or G (SAP rating < 68)^a

Qualifying benefit or condition	Target group:		Eligible by not in target group (in receipt of means tested benefits)			Total households
	Below income threshold, vulnerable, on MTBs	Below income threshold, vulnerable, not on MTBs	Below income threshold, not vulnerable, on MTBs	Above income threshold, vulnerable, on MTBs	Above income threshold, not vulnerable, on MTBs	
Pension Credit	44,437	0	825	4,400	459	50,121
Income ESA	5,898	0	37	0	256	6,192
Incapacity Benefit	10,568	0	1,443	10,139	0	22,150
Severe Disablement Allowance	2,473	0	0	691	0	3,164
Income Support	15,389	0	0	3,847	515	19,751
JSA income	9,225	0	2,241	87	85	11,637
Child Tax Credit (and income below threshold)	21,370	0	0	0	0	21,370
Respiratory illness (and income below threshold)	5,766	2,438	0	0	0	8,204
Circulatory illness (and income below threshold)	7,198	1,691	0	0	0	8,889

Source: Modelled Wales Housing Stock constructed for the NHM by CSE using the EHS 2012 and the LiW survey 2008.

^a Households can be in receipt of more than one qualifying benefit or condition so numbers in groups do not sum to totals shown in other tables.

Table 3.9 The numbers of households and median income for different groups of households, split by eligibility for the scheme, for private rented or owner occupied dwellings in SAP bands E, F or G (SAP rating < 54)

Household income	Eligible households		Households not eligible	
	Number of households	Median income	Number of households	Median income
Income above 60% median	12,934	£19,207	1,049,506	£27,464
Income below 60% median, but with no additional vulnerability	4,128	£8,262	36,240	£8,243
Income below 60% median, with dependent children/older adults/long-term sick or disabled (including those with circulatory or respiratory diseases)	51,077	£10,631	149,305	£12,219

Source: Modelled Wales Housing Stock constructed for the NHM by CSE using the EHS 2012 and the LiW survey 2008.

Table 3.10 The numbers of households and median income for different groups of households, split by eligibility for the scheme, for private rented or owner occupied dwellings in SAP bands D, E, F or G (SAP rating < 68)

Household income	Eligible households		Households not eligible	
	Number of households	Median income	Number of households	Median income
Income above 60% median	16,245	£17,911	1,046,195	£27,485
Income below 60% median, but with no additional vulnerability	4,568	£8,262	35,800	£8,035
Income below 60% median, with dependent children/older adults/long-term sick or disabled (including those with circulatory or respiratory diseases)	90,945	£11,485	109,436	£12,252

Source: Modelled Wales Housing Stock constructed for the NHM by CSE using the EHS 2012 and the LiW survey 2008.

Varying the eligibility criteria with budget size

- 3.95 A refinement of the eligibility criteria outlined above is also suggested to ensure that if less money is available, it is the highest priority groups that are tackled. As budgets are expanded, lower priority groups could be included in the eligible groups of households.

- 3.96 It is important to note that selecting a 'most vulnerable' group is to some degree a subjective exercise. In this instance, using the evidence from the literature, it was decided that the most vulnerable households should be those households with the youngest children (aged under five years) or the oldest adults (aged over 75 years). A significant proportion of the older adult households included in this group also include people with long term illnesses or disabilities.
- 3.97 The different vulnerable groups are presented in Table 3.11 below, with the vulnerability level of 1 indicating the most vulnerable. In all levels, all types of vulnerabilities previously identified are represented. It should be noted that, as discussed above, qualifying households will need to demonstrate the age of an inhabitant matches the criteria. This can be simply done with commonly held documents showing proof of address and age, such as utility bills, passports, driving licenses. The total numbers of households in each of these groups was determined using the Wales housing and household stock dataset created for the project, with the energy efficiency rating modelled by the NHM.
- 3.98 In order to estimate the number of homes that could be provided with measures under various annual scheme budgets, the average cost of improving a dwelling under the Warm Homes Nest scheme was used as a guide. This allowed the size of the four groups shown in Table 3.11 to be estimated.
- 3.99 Different approaches to publicising the scheme and the methods by which households can evidence their eligibility will affect response rates. As noted above, an overarching consideration was that the eligibility criteria must prevent the pool of eligible households becoming too large, potentially resulting in over subscription, waiting lists, or closure of the scheme in-year. Over-subscription is a less favourable option than under-subscription and while a good balance should be achieved, the priority was to avoid in-year closure.

3.100 In order to demonstrate eligibility if the scheme had a lower annual budget and was targeting only those of a certain age then identification documents such as a passport or birth certificate would also have to be presented.

Table 3.11 Summary of the eligibility criteria by proposed scheme budget

Vulnerability Level	Households eligible	Energy Efficiency (SAP rating)	Number of households	Annual scheme budget
1	Households with members who are over 75 years or under 5 years AND in receipt of any of the means tested benefits specified	E,F or G	23,457	£10 million
2	Households with members who are over 75 years or under 5 years AND in receipt of any of the means tested benefits specified; OR Low income households which include people with a respiratory or circulatory disease	E,F or G	49,696	£25 million
3	Households which include people who are in receipt of any of the means tested benefits specified; OR Low income households which include people with a respiratory or circulatory disease	E,F or G	68,139	£50 million
4	Households which include people who are in receipt of any of the means tested benefits specified; OR Low income households which include people with a respiratory or circulatory disease	D, E, F or G	111,758	£100 million

How should the scheme be publicised?

3.101 Even if a third party referral scheme is not chosen the agencies listed above (in the third party referral option, Paragraph 3.79) should still be used for wider publicity of the scheme and used to help market and raise awareness of its benefits. These organisations all interact with vulnerable households and would therefore provide a means of reaching people who are most at risk and therefore likely to be eligible for the scheme.

3.102 With particular reference to third party referral systems, the importance of alliances between organisations should be also recognised. These alliances could encompass a variety of different agencies which, complementing the current NEST advice services, could – amongst other important work - be used to streamline the third party referral process. Several of these alliances have been set up around the UK in recent years. For example, ‘Safe and Independent Living’ schemes exist in Dorset, Southwark, Lambeth and Wiltshire in England. They involve partnerships between local authorities, fire and rescue services, police forces, third sector organisations, energy advice services, local and national charities and the local health service. The Wales Accord on the Sharing of Personal Information (WASPI) is a similar framework in operation in Wales¹⁰. Robust and effective alliances like these could: allow information sharing on vulnerable households between agencies with common goals, increase the reach of these organisations, and make each contact count meaning that most households will only have to explain their situation once.

3.103 In order to make potential beneficiaries aware of the scheme’s existence it will be important to target marketing material at eligible groups. For instance, in order to target those on means tested benefits it will be important for marketing materials to clearly advertise which people, and on which particular benefits, are eligible for the scheme.

Recommended approach

3.104 It is recommended that a future energy efficiency scheme for Wales should target any household with all four of the following characteristics:

- A **relatively low income** (below 60% of the median);
- An **additional vulnerability** (an adult aged over 65 years; a dependant child; an individual with a disability, long term health condition or a respiratory or circulatory disease)
- A home that is owner occupied or privately rented; and

¹⁰ <http://www.waspi.org>

- A home that is **energy inefficient** (as indicated by having a SAP band rating of E, F or G, and, if higher levels of funding are available, band D).
- 3.105 As noted in Paragraph 3.45, further work and consultation is recommended to assess the best process for targeting people with mental health problems and allowing them to demonstrate their eligibility for a future scheme.
- 3.106 Households should be reached through a combination of promotional materials and using a wide range of different agencies currently working with vulnerable households. Promotional materials should be developed to assist agencies publicising the scheme, raise awareness of the assistance it provides and clearly indicate which types of people qualify for the scheme.
- 3.107 It is recommended that households should demonstrate their eligibility for the scheme through proof of receipt of **means tested benefits**. This will not pick up everyone in the target group but previous analysis shows that this is a reasonable way of allowing a satisfactory proportion of the target group to demonstrate eligibility. However, to enhance the targeting process it is further recommended that households on relatively low incomes and with respiratory, circulatory or mental health conditions should qualify for the scheme through a referral process administered by approved third party organisations.
- 3.108 It is recommended that the eligibility criteria should be refined depending on the size of the annual scheme budget the eligibility criteria should be refined in order to prioritise the most vulnerable households where the budget is more limited. With an annual budget of £10 million it is recommended that, in order to be eligible, a household must contain a member aged over 75 years or under 5 years; with an annual budget of £25 million the criteria should be expanded to contain low income people with a respiratory or circulatory disease. With an annual budget of £50 million or £100 million all qualifying households (as described above in paragraph 3.96 and table 3.11) should be considered. In addition, for the largest

spend it is recommended that households with an energy efficiency of D should be brought into consideration.

4. Phase 2: Modelling energy improvement schemes targeted at the eligible households

- 4.1 This section presents a summary of the results from modelling the application of various energy efficiency scheme budget scenarios to households in Wales using the NHM. The results presented here include a brief analysis of the baseline situation for all households in Wales in 2015. The results from modelling each of four budget scenarios are then presented. The impact of targeting annual home energy efficiency improvement budgets of £10M, £25M, £50M and £100M at groups of vulnerable households in Wales is modelled. The section concludes with some headline findings from the modelling.
- 4.2 For each of the four scenarios, the set of eligibility criteria was altered to account for the increasing budgets, as described previously in Section 3. Table 4.12, below, summarises the groups targeted for each scenario. For all budget scenarios, it is assumed that those low income households that include a member with a disability or long-term limiting illness are captured by the means tested benefits specified in Paragraph 3.56.
- 4.3 It should also be noted that, as discussed in Paragraphs 3.45 and 3.46, although it is recommended that people with mental health problems are included in the qualifying vulnerabilities for any future scheme, there is further work to be done to identify precisely which mental health conditions and of what duration might allow an individual to qualify to receive measures. Since modelled estimates based on all individuals reporting any form of mental health problem would significantly overestimate the numbers of dwellings that would become eligible, people with mental health problems were excluded from the modelling exercise.
- 4.4 It should be noted that widening the eligibility criteria as the budget increases also increases the 'number' of dwellings eligible for measures, resulting in a different initial distribution of energy efficiency ratings. Hence, for example, the baseline proportion of homes rated F and G was 31% for the £25M scenario while for the £50M scenario, the baseline proportion of

homes rated F and G is 36%. Both scenarios reduce this to 11%, but having a large group to begin with the £50 scenario has therefore improved more homes to E or above.

- 4.5 It may serve as a useful reminder to clarify which households are being referred to here when discussing ‘target’ households and ‘eligible’ households.

Target households are those that we have identified as at high risk of living in cold homes and susceptible to the harmful effects from living in cold homes. These are the households that would be reached by the scheme in a perfect targeting situation as described in Paragraph 3.92.

Eligible households are those that meet the eligibility criteria recommended in Section 3, and are thus eligible for measures. Some vulnerable target households will not be reached using these eligibility criteria and a proportion of eligible households will not necessarily be ‘vulnerable’ or low income as outlined in Table 3.7 and Table 3.9.

Table 4.12 Household Characteristics and Energy Efficiency Rating for Eligible groups by annual scheme budget

Annual budget	Household characteristics	Housing tenure	Energy efficiency (SAP rating)
£10 m	Households with members who are aged over 75 years or less than 5 years AND in receipt of any of the means tested benefits specified in Paragraph 3.56.	Private rented or owner occupied	E,F or G
£25 m	Households with members who are aged over 75 years or less than 5 years AND in receipt of any of the means tested benefits specified in Paragraph 3.56; OR Low income households which include people with a respiratory or circulatory disease	Private rented or owner occupied	E,F or G
£50 m	Households which include people who are in receipt of any of the means tested benefits specified in Paragraph 3.56; OR Low income households which include people with a respiratory or circulatory disease	Private rented or owner occupied	E,F or G
£100 m	Households which include people who are in receipt of any of the means tested benefits specified in Paragraph 3.56; OR Low income households which include people with a respiratory or circulatory disease	Private rented or owner occupied	D, E, F or G

Summary of the baseline situation in Wales in 2015

4.6 The main types of vulnerable households as discussed in Section 3 are listed below in

4.7 able 4.13. The summary information provided includes information about the estimated average SAP rating, energy bills and carbon emissions of the housing inhabited by vulnerable households taken from the Welsh housing stock used in the NHM. This data was calculated by the NHM before any improvement modelling occurred and therefore represents the baseline situation. This data is for all dwellings – i.e. dwellings of all SAP ratings - a subset of this group live in properties with SAP ratings of D, E, F or G.

Table 4.13 Average estimated energy efficiency ratings, energy bills and domestic carbon emissions by household type

Type of household		Average SAP	Average bill (£)	Average emissions (tCO ₂)	Number of dwellings
Target Group (relative low income and vulnerable)	In receipt of MTB	52	£1,513	5.1	158,477
	Not in receipt of MTB	44	£1,620	5.7	5,972
Eligible but outside target group	Below income threshold, not vulnerable, on MTBs	55	£1,277	4.1	14,424
	Above income threshold, vulnerable, on MTBs	58	£1,157	3.7	52,615
	Above income threshold, not vulnerable, on MTBs	58	£921	3.3	3,737
Not eligible for scheme		48	£1,864	6.7	1,066,715
All Wales households		49	£1,782	6.3	1,301,940

4.8 Table 4.13 suggests that the housing of low income vulnerable households **not** on means tested benefits is, on average, the least efficient and the most expensive to heat. The average SAP rating of this group is 44 (EPC E), 8 points lower than the target group who **are** in receipt of means tested benefits and 14 SAP points lower than the group of households who qualify for the scheme due to being in receipt of means tested benefits and having an additional vulnerability but who are not on a relative low income. Correspondingly, the average fuel bill for low income vulnerable households **not** on means tested benefits (MTB) is the highest of all the groups we are recommending are made eligible for the scheme. Although the size of the target group who are not on MTB is small, these statistics highlight the need to ensure that vulnerable households on low incomes but

not on means tested benefits should be included in the target group for any future energy efficiency scheme.

- 4.9 With the exception of low income vulnerable households **not** on means tested benefits, households we propose should be eligible for the scheme have on average more efficient and cheaper to heat dwellings than those on higher incomes. This is the result of a number of factors. For example, low income households tend to live in smaller properties. However, although low income households have cheaper bills on average, those bills represent a greater proportion of their income than for households on incomes above the low income threshold. As discussed above in paragraph 3.26 there is evidence that many low income households will routinely under heat homes in an attempt to make energy bills more manageable. Furthermore, it is important to remember that many low income vulnerable households also live in some of the least energy efficient homes in Wales. It is these low income vulnerable households living in energy inefficient homes that have been targeted in the modelling and reported on below.

Scenario 1: £10 million annual budget

With the lowest budget only the most vulnerable groups were targeted: to be eligible a household had to be in receipt of a means tested benefit (specified in Paragraph 3.56) and include a household member who is aged under 5 years or over 75 years. Each house has an individual spending cap, determined by its characteristics, as defined in Table 2.2.

Eligible group: *Households with members who are aged **over 75 years** or **under 5 years** and on any of the means tested benefits specified in Paragraph 3.56; living in private rented or owner occupied dwellings with **SAP ratings E, F or G.***

- 4.10 The modelling results show that an annual budget of £10 million could allow the efficiency of approximately 21,400 homes currently with SAP ratings of E, F or G to be improved.
- 4.11 Table 4.14 indicates the number and proportion of each eligible group who received measures during the scenario, split between those households who were in the target group and those who were eligible due to receiving

means tested benefits but not in the target group. It should be noted that some groups listed in Table 4.14 do not receive measures under this scenario. This is due to small numbers in the surveys on which the modelling is based and the resulting low probability of selection when using random sampling to select qualifying households to be improved.

- 4.12 The majority (91.5 per cent) of households who received measures were in the target group i.e. were inhabited by vulnerable households who are below the low income threshold. A minority (8.5 per cent) of households who are above the low income threshold received measures, but all of these homes contained people in receipt of means tested benefits and have household members who are aged either under five years or over seventy-five years. No low income households without an additional vulnerability received measures under this scenario.

Table 4.14 Average cost of measures and bill reduction by household type; annual scheme budget: £10 million^a

Type of household		Number of dwellings which receive a measure	Proportion receiving measures	Average Cost of Measures	Average Bill Reduction
Target Group (relative low income and vulnerable)	In receipt of MTB	19,335	90.3%	£2,428	£332
	Not in receipt of MTB	261	1.2%	£52	£23
Outside of target group but eligible	Below income threshold, not vulnerable, on MTBs	0	0%	£0	£0
	Above income threshold, vulnerable, on MTBs	1,811	8.5%	£1,662	£224
	Above income threshold, not vulnerable, on MTBs	0	0%	£0	£0
Total		21,407	100%	100%	£2,335

^a Some groups listed do not receive measures under this scenario. This is due to small numbers in the surveys on which the modelling is based and the resulting low probability of selection when using random sampling to select qualifying households to be improved.

- 4.13 The average costs of measures installed varied across the stock and for different groups. Vulnerable households above the low income threshold but on means tested benefits received on average lower cost measures, with the average improvements costing approximately £1,662. Low income households with additional vulnerability characteristics received measures with an average cost of £2,428, see Table 4.14 above.
- 4.14 Table 4.15, below, shows the breakdown of those who received measures by their starting SAP band and heating fuel. With an annual spend of £10 million, around 7,000 properties in bands F and G, and a further 14,500 in band E received measures. The majority of these homes were connected to the gas grid. On average, the cost of measures installed in properties heated with mains gas was significantly lower than the cost of measures installed in homes without mains gas, reflecting the hard-to-treat nature of off gas homes.

Table 4.15 Improvements in SAP, emissions and fuel bills after installation of measures, by initial heating fuel and SAP band - annual scheme budget: £10 million

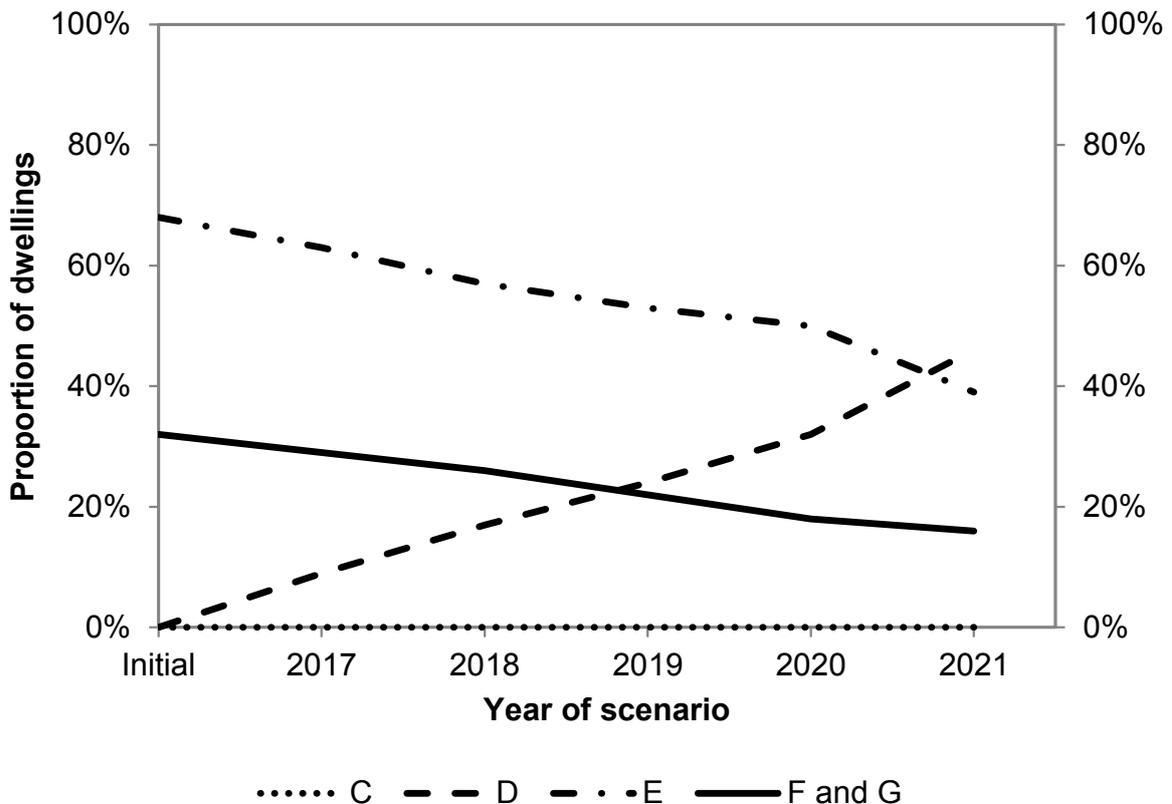
Heating Fuel	Original SAP Band	Average carbon emissions reduction (t.CO ₂)	Average energy bills reduction (£)	Average SAP score increase	Average costs of measures (£)	Number of dwellings receiving measures
Mains gas	E	0.8	£195	9	£1,556	12,868
	F or G	1.6	£457	19	£2,169	3,523
Non-mains gas	E	1.3	£375	5	£3,740	1,678
	F or G	2.0	£626	16	£4,806	3,338
Overall		1.2	£319	12	£2,335	21,407

- 4.15 On average, spending £10 million per year decreased the annual energy bills of those receiving measures by £319, increased SAP ratings by 12 points and decreased annual household CO₂ emissions by 1.2 t.CO₂. However, the improvements experienced by F and G rated properties were more pronounced. Non-mains gas F and G rated properties experienced an average reduction in annual bills of £550 and a SAP increase of approximately 16 points; mains gas F and G rated properties had an

average SAP score increase of 19 points and an average reduction in annual bills of £457. This reflects both the greater potential for improvement of the most inefficient homes and the larger spending caps afforded to them (see Table 2.2, Section 2).

4.16 Figure 4.3 shows the proportion of households with different SAP ratings over the five year programme for all households who received measures. Over the course of the scenario, the proportion of the stock in each SAP band changes as improvements are made and properties jump to higher SAP bands. At the start of the scenario, the greatest share (68 per cent) of properties is in SAP band E. Over the course of the scenario, the share of the SAP band E group decreases to 39 per cent, with the numbers in bands F and G also decreasing to 8 per cent in each. Correspondingly, the proportion in SAP band D increases from 0 per cent to 46 per cent.

Figure 4.3 The proportion of dwellings in each SAP band over the lifetime of a scheme - annual budget: £10 million (all eligible households n = 21,407)



Scenario 2: £25 million annual budget

With this budget the group targeted was expanded slightly to include an additional eligibility criterion: a household could qualify through either a) being in receipt of a means tested benefit (specified in Paragraph 3.56) and include a household member who is under 5 years or over 75 years OR b) be in relative low income and include someone who suffered from respiratory or circulatory disease, as referred by a third party agency. These chronic diseases were identified by the literature review as being the most likely to be aggravated by living in a cold home. The individual spending caps on each dwelling remained the same as for the previous £10 million scenario (as defined in Table 2.2).

Eligible group: *Households with members who are aged **over 75 years or under 5 years** and on any of the means tested benefits (specified in Paragraph 3.56) **OR** relative **low income households** with people who suffer from **respiratory or circulatory diseases**; living in private rented or owner occupied dwellings with **SAP ratings E, F or G.***

- 4.17 It should be noted that some groups listed in Table 4.16 do not receive measures under this scenario. This is due to small numbers in the surveys on which the modelling is based and the resulting low probability of selection when using random sampling to select qualifying households to be improved.
- 4.18 As Table 4.16 shows, the main impact of increasing the budget and widening the eligibility criteria was to reach more households (over 36,700). The bulk of these households (76 per cent) were households below the income threshold with additional vulnerabilities. The remaining 24 per cent of households receiving measures were those who were above the low income threshold but had household members with additional vulnerabilities - these households qualified for the scheme due to being in receipt of means tested benefits.
- 4.19 This scenario reached approximately 7,000 off gas F and G properties (as shown in Table 4.17 below). The higher spending cap for these dwellings resulting in higher cost measures being installed, and as a result the average expenditure per house across the whole scenario was approximately £1,000 more than for the £10M scenario. This greater level

of investment also resulted in a higher overall average reduction in annual bills of £347.

Table 4.16 Average cost of measures and bill reduction by household type - annual scheme budget: £25 million^a

Type of household		Number of dwellings which receive a measure	Proportion receiving measures	Average Cost of Measures	Average Bill Reduction
Target Group (relative low income and vulnerable)	In receipt of MTB	25,373	69.1%	£3,334	£398
	Not in receipt of MTB	2,681	7.3%	£6,073	£313
Outside of target group but eligible	Below income threshold, not vulnerable, on MTBs	0	0%	£0	£0
	Above income threshold, vulnerable, on MTBs	8,671	23.6%	£2,781	£238
	Above income threshold, not vulnerable, on MTBs	0	0%	£0	£0
Total		36,725	100%	£3,403	£354

^a Some groups listed do not receive measures under this scenario. This is due to small numbers in the surveys on which the modelling is based and the resulting low probability of selection when using random sampling to select qualifying households to be improved.

4.20 On average, an investment of approximately £3,400 increased SAP ratings by 14 points for the 36,725 homes getting measures under the £25 million scenario. With an annual spend of £25 million, around 11,300 properties in bands F and G, and a further 25,500 in band E received measures, as shown in Table 4.17. The greatest SAP rating increase was achieved in F and G rated, mains gas heated properties - an average spend of £3,100 resulted in an average 29 point increase in SAP rating and a bill reduction of £705 for these 3,390 households. Off gas properties received larger investments on average, with off gas F and G rated dwellings receiving an average spend of approximately £6,700 - this caused SAP ratings to rise by

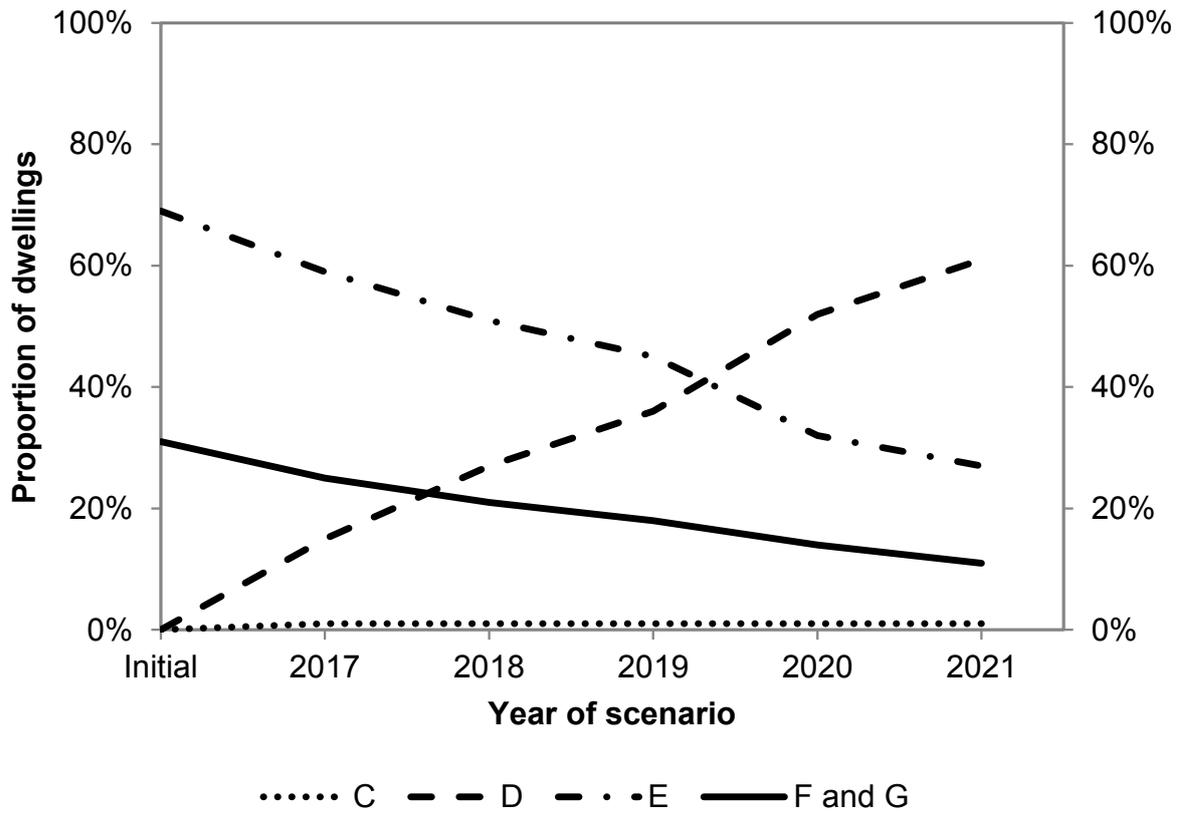
an average of 15 points, annual energy bills to be reduced by approximately £495 and carbon emissions to fall by on average 1.8 t.CO₂.

Table 4.17: Improvements in SAP, emissions and fuel bills after installation of measures, by initial heating fuel and SAP band - annual scheme budget: £25 million

Heating Fuel	Original SAP Band	Average carbon emissions reduction (t.CO ₂)	Average energy bills reduction (£)	Average SAP score increase	Average costs of measures (£)	Number of dwellings receiving measures
Mains Gas	E	1.1	£267	12	£2,365	23,350
	F or G	2.4	£705	29	£3,099	3,390
Non-mains gas	E	0.7	£211	5	£2,895	2,046
	F or G	1.8	£495	15	£6,717	7,939
Overall		1.4	£354	14	£3,403	36,725

- 4.21 Figure 4.4 shows the changing energy efficiency profile of all eligible households over the five-year duration of this scenario. The results show that an annual budget of £25 million has the potential to make significant reductions in the numbers of E, F and G rated dwellings. On completion of the five year programme, the proportion of dwellings rated F or G decreases from 31 per cent to 11 percent, and homes rated D increased from 0 to 61 per cent, with 1 per cent of homes improved to a SAP rating C.
- 4.22 It should be noted that all properties remaining in Bands F or G received measures, but were not suitable for all types of measure so the level of improvement was not always sufficient to increase these dwellings to a SAP rating of more than 38 and therefore into band E (see Figure 3.2). Nevertheless, such households would still benefit from the improvements that were made and would experience a reduction in their energy bills. However, taking them beyond the SAP F band threshold would be likely to require higher spending caps and the installation of more expensive measures such as solid wall insulation.

Figure 4.4: The proportion of dwellings in each SAP band over the lifetime of a scheme - annual budget: £25 million (all eligible households - n = 36,725)



Scenario 3: £50 million annual budget

For this scenario the eligibility criteria were further expanded to a wider target group: a household could qualify through either a) being in receipt of a means tested benefit (specified in Paragraph 3.56) OR b) be in relative low income and include someone who suffered from respiratory or circulatory disease, as referred by a third party agency. The individual spending caps on each dwelling remained the same as for the previous two scenarios (as defined in Table 2.2).

Eligible group: *Households with members who receive any of the specified means tested benefits (specified in Paragraph 3.56) living in private rented or owner occupied dwellings with **SAP ratings E, F or G.***

OR

*Households on a **low income** containing people who suffer from a **respiratory or circulatory disease** living in private rented or owner occupied dwellings with **SAP ratings E, F or G.***

- 4.23 Widening the eligibility criteria increased the numbers receiving measures by approximately 26,000, with just over 63,000 dwellings being improved over five years. Households below the low income threshold with an additional vulnerability received 77 per cent of the measures. A further 6 per cent of those receiving measures were relatively low income households without any additional vulnerability. Additionally, 17.5 per cent of households receiving measures were above the low income threshold, but qualified for the scheme through being in receipt of a means tested benefit.
- 4.24 The average cost of measures for Scenario 3 was higher than under the £10M and £20M scenarios, with an average investment of approximately £4,000 per dwelling.

Table 4.18 Average cost of measures and bill reductions - annual scheme budget: £50 million

Type of household		Number of dwellings receiving measures	Proportion receiving measures	Average Cost of Measures	Average Bill Reduction
Target Group (relative low income and vulnerable)	In receipt of MTB	45,332	71.7%	£4,091	£402
	Not in receipt of MTB	3,282	5.2%	£7,047	£288
Outside of target group but eligible	Below income threshold, not vulnerable, on MTBs	3,527	5.6%	£3,691	£538
	Above income threshold, vulnerable, on MTBs	10,340	16.4%	£2,609	£228
	Above income threshold, not vulnerable, on MTBs	708	1.1%	£1,479	£92
Total		63,189	100.0%	£3,950	£371

- 4.25 On average, an annual investment of £50 million targeted at eligible households reached 63,189 homes over five years, reducing energy bills by £371, increasing average SAP scores by 13 points and reducing annual carbon emissions by 1.2 t.CO₂.
- 4.26 Around 23,000 properties in bands F and G, and a further 40,000 in band E received measures, as shown in Table 4.19.
- 4.27 The results demonstrate that off-gas properties generally require a larger investment for comparable improvements. For example, the 15,500 off gas homes rated F and G received an average of £8,500 worth of measures, increasing SAP scores by 15 points, and reducing annual energy bills and carbon emissions by £620 and 1.3 t.CO₂ respectively. In contrast, F and G properties using mains gas heating systems received an average investment of £3,147 but experienced an increase of 21 SAP points and a reduction in annual energy bills and carbon emissions of £514 and 1.9 t.CO₂ respectively. The greater cost efficiency in mains gas heated

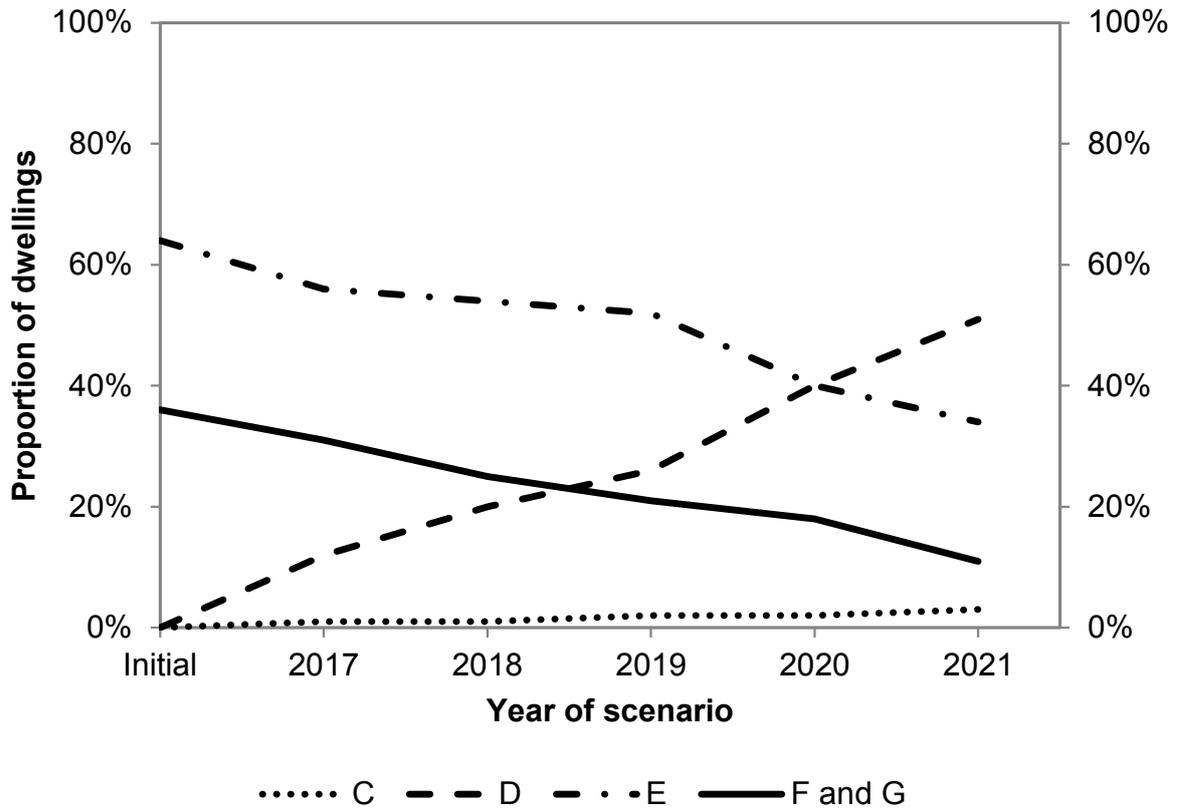
properties underlines the increased difficulty and levels of investment required to improve the most inefficient and hard-to-treat off gas homes.

Table 4.19 Improvements in SAP, emissions and fuel bills after installation of measures, by initial heating fuel and SAP band - annual scheme budget: £50 million

Heating Fuel	Original SAP Band	Average carbon emissions reduction (t.CO ₂)	Average energy bills reduction (£)	Average SAP score increase	Average costs of measures (£)	Number of dwellings receiving measures
Mains Gas	E	1.1	£250	11	£2,304	37,241
	F or G	1.9	£514	21	£3,147	7,490
Non-mains gas	E	0.9	£232	5	£2,836	2,896
	F or G	1.3	£620	15	£8,484	15,562
Overall		1.2	£371	13	£3,950	63,189

4.28 Figure 4.5 shows the changing energy efficiency profile of all eligible households over the five-year duration of the £50 million scenario. Under this scenario, the numbers of homes rated F or G is reduced from 36 per cent to 11 per cent. The proportion of homes rated E reduces from 64 per cent to 34 per cent. The majority of eligible homes at the end of the five year scenario are rated D (51 per cent), with a further three per cent rated C.

Figure 4.5: The proportion of dwellings in each SAP band over the lifetime of a scheme - annual budget: £50 million (all eligible households - n = 68,139)



Scenario 4: £100 million annual budget

For the £100 million annual spend scenario the low income vulnerable group eligibility was the same as the previous £50 million scenario: a household could qualify through either a) being in receipt of a means tested benefit (specified in Paragraph 3.56) and include a household member who is under 5 years or over 75 years OR b) be in relative low income and include someone who suffered from respiratory or circulatory disease, as referred by a third party agency. However, the individual spending caps on each dwelling were expanded (as defined in Table 2.2), and once the majority of homes rated in SAP bands E, F or G had received a measure, dwellings in SAP band D also qualified for the scheme.

Eligible group: *Households who receive any of the means tested benefits specified, living in private rented or owner occupied dwellings with **SAP ratings D, E, F or G***

OR *Households on a **low income** containing people who suffer from either a **respiratory or circulatory disease**, living in private rented or owner occupied dwellings with **SAP ratings D, E, F or G.***

- 4.29 Increasing the budget to £100 million meant that a further shift in eligibility criteria needed to be considered, because initial modelling showed that using the same eligibility criteria as for the £50m scenario but with an annual spend of £100 million resulted in all eligible households (those in receipt of a qualifying benefit or on a low income and with a respiratory or circulatory illness) having their homes improved within the first two years of the scenario. The eligibility criteria was therefore broadened for this scenario to include D-rated dwellings, but only once the majority of E, F and G rated properties had received measures. The spending limits for E, F and G rated properties remained the same; for D rated properties the limits were set at the same level as for E, i.e. £4,000 for on-gas properties and £8,000 for off-gas.
- 4.30 By increasing the annual budget to £100 million, the number of households receiving measures over five years increased to over 110,500, with an average spend of just over £3,000. Adjusting the eligibility criteria to include D rated properties and increasing the level of annual funding enabled a

higher percentage of vulnerable, low income households to receive energy efficiency improvement measures over the five year programme. The targeting of this group was relatively efficient, with vulnerable households below the low-income threshold receiving 81 per cent of the measures. Relative low income households without any further vulnerability made up an additional 4 per cent of the group receiving measures.

- 4.31 However, increasing the funding also meant that a number of households who were above the low income threshold received measures. In total, over 16,000 households that were not below the low income threshold received improvement measures, representing approximately 15 per cent of people benefiting from the scheme. These households received measures because they were in receipt of qualifying benefits, and, as shown in the previous section, are still likely to be on significantly lower incomes than non-qualifying households.
- 4.32 There is substantial variation in the costs and impacts of the measures, depending on the characteristics of the property. As Table 4.20 shows, the average cost of installing measures in off gas properties rated F or G was approximately £9,250. On average, these homes experienced a SAP increase of 16 points, a reduction in annual energy bills of £652 and an emissions reduction of 1.3 t.CO₂ per annum.

Table 4.20 Average cost of measures and bill reduction - annual scheme budget: £100 million

Type of household		Number of dwellings	Proportion receiving measures	Average Cost of Measures	Average Bill Reduction
Target Group (relative low income and vulnerable)	In receipt of MTB	86,118	77.8%	£2,990	£283
	Not in receipt of MTB	3,864	3.5%	£5,641	£316
Eligible but outside target group	Below income threshold, not vulnerable, on MTBs	4,541	4.1%	£3,399	£448
	Above income threshold, vulnerable, on MTBs	14,924	13.5%	£2,420	£209
	Above income threshold, not vulnerable, on MTBs	1,227	1.1%	£1,881	£101
Total		110,674	100%	£3,010	£279

4.33 Over the lifetime of the scenario, 23,000 properties in bands F and G were improved and 40,000 in band E. A further 48,000 in band D received measures. Despite this, the on-gas D rated properties received the greatest share (43 per cent) of the measures that were installed. However, the results in Table 4.21 show that F and G rated properties accounted for the majority of off-gas homes receiving measures. Twice the number of non-mains gas homes were rated F or G (15,562) than homes with mains gas heating systems (this trend is true of other scenarios, but more pronounced here.); this highlights that the majority of low income vulnerable households in off gas properties are likely to be living in the most inefficient, most expensive to heat and coldest of homes.

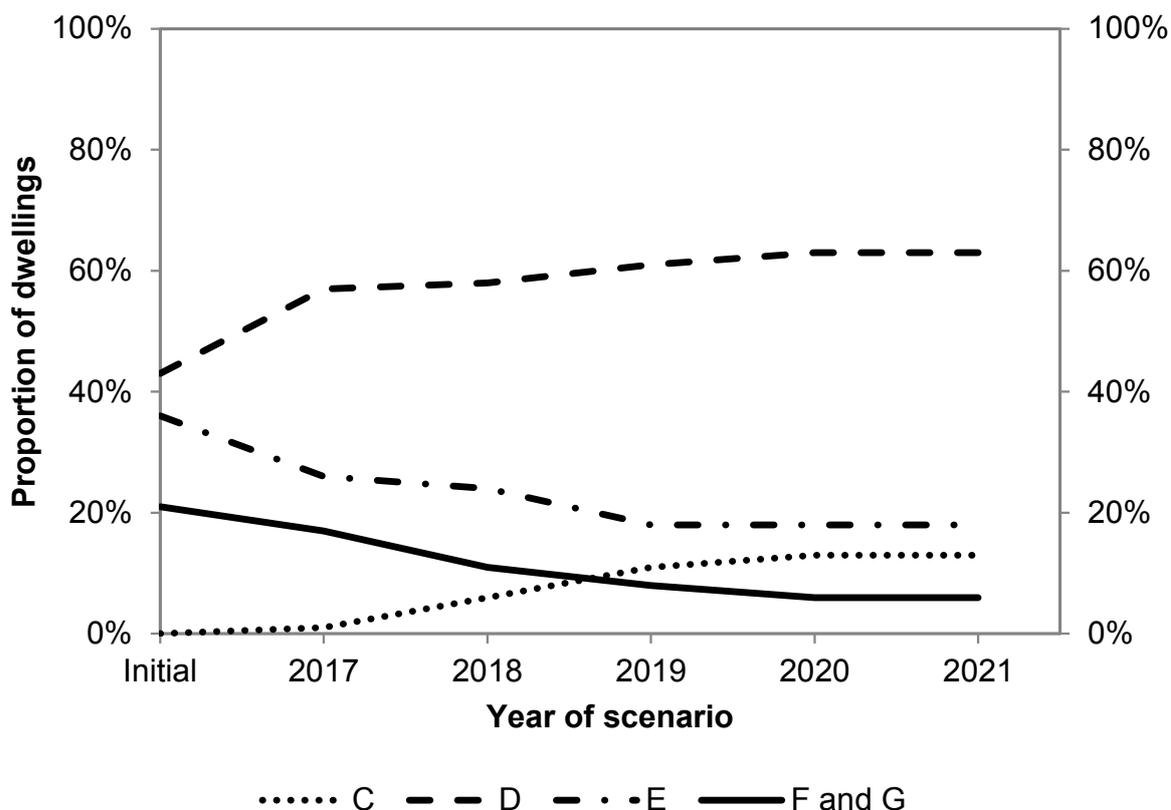
4.34 The modelling results suggest that an average investment of £3,000 per dwelling under this scenario could cause energy bills to decrease by £279, SAP ratings to increase by an average of 10 points and annual carbon emissions to fall by 0.9 t.CO₂.

Table 4.21: Improvements in SAP, emissions and fuel bills after installation of measures, by initial heating fuel and SAP band - annual scheme budget: £100 million

Heating Fuel	Original SAP Band	Average carbon emissions reduction (t.CO ₂)	Average energy bills reduction (£)	Average SAP score increase	Average costs of measures (£)	Number of dwellings receiving measures
Mains Gas	D	0.5	£134	6	£1,377	47,410
	E	1.1	£261	11	£2,370	37,241
	F or G	1.9	£507	20	£3,231	7,490
Non-mains gas	D	1.1	£321	5	£6,202	75
	E	1.2	£301	6	£3,747	2,896
	F or G	1.3	£652	16	£9,260	15,562
Overall		0.9	£279	10	£3,010	110,674

4.35 Figure 4.6 shows the changing energy efficiency profile of all eligible households over the five-year duration of the £100 scenario. The proportion of properties in band D increases from 43 per cent to 63 per cent and the proportion of C rated properties increases from 0 to 13 per cent. Correspondingly, the proportion of E rated properties falls from 36 per cent to 18 per cent and the share of F and G rated properties from 21 per cent to 6 per cent. Initially, over half of households live in E, F and G rated homes; on completion of the five year programme, less than a quarter of homes were in bands E, F and G, with 76 per cent of homes rated C or D.

Figure 4.6: The proportion of dwellings in each SAP band over the lifetime of a scheme - annual budget: £100 million (all eligible households - n = 110,674)



Summary of modelling analysis

- 4.36 Some headline results from the four scenarios are presented here in order to better demonstrate the impact of incrementally increasing the energy efficiency programme budget and widening the eligibility criteria.
- 4.37 Table 4.22 summarises the four budget scenarios and shows the total number of eligible households, the total number of households who are modelled to receive measures, the average bill reduction and the average investment per dwelling. The average cost per household generally increases from the £10 million to £50 million scenario as more off gas dwellings with higher spending caps are improved. Widening the eligibility criteria to D rated properties results in slightly lower average costs per household.

Table 4.22 Number of eligible households, average expenditure and impact on energy bills by scenario

Annual Budget	Number of households in eligible group	Number of eligible households receiving measures	Average annual bill reduction	Average expenditure per dwelling
£10m	23,457	21,407	£319	£2,335
£25m	49,696	36,725	£354	£3,403
£50m	68,139	63,189	£371	£3,950
£100m	111,758	110,674	£279	£3,010

4.38 Table 4.23 shows the number of different measures that were installed in eligible households over the five year lifetime of each scenario. Using a spending cap for each dwelling ensures that the majority of measures that were installed were the more cost-effective measures such as efficient mains gas condensing combination boiler, loft insulation and cavity wall insulation.

4.39 For the £10 million scenario, these measures represented approximately 58 per cent of all installed measures. In addition, low energy lighting also featured prominently in this scenario – the modelling recommended the installation of low energy light bulbs in around 18,000 dwellings. This is often a low cost intervention that can make an important difference in reducing electricity bills.

Table 4.23 The type and number of measures installed by scenario^a

Measure	Budget scenario			
	£10 m (no. of dwellings)	£25 m (no. of dwellings)	£50 m (no. of dwellings)	£100 m (no. of dwellings)
A-rated mains gas condensing boiler	9,402	18,922	31,840	49,519
Modern fan assisted storage heaters	254	747	3,740	4,294
Loft insulation	14,282	29,983	54,104	91,829
External solid wall insulation	261	1,180	2,296	1,996
Cavity wall insulation	5,284	10,040	15,992	29,804
Low energy lighting^b	18,222	32,836	53,737	91,072
Air source heat pump	1,114	245	1,215	2,003
Solar photovoltaic panels	1,440	6,526	13,541	17,636
Solar thermal panels	0	652	3,464	5,020
Average number of measures per dwelling	2.3	2.8	2.8	2.6
Total number of measures	50,258	101,129	179,929	293,172

a Figures relate to the number of dwellings receiving an intervention.

b Figures relate to the numbers of dwellings receiving this type of measure rather than the number of light bulbs required – the number of light bulbs will vary for each household based on the size and type of dwelling and the number of existing low energy light bulbs.

4.40 As annual budgets increased, the mixture of measures shifted. As more funding became available, more expensive and lower carbon technologies began to be installed. In particular, the proportion of households receiving solar PV steadily increases as the spending goes up. This was particularly the case for D rated dwellings in the £100 million scenario where more cost-effective measures had already been installed and these types of measures were required to further improve the efficiency of these dwellings. Other low carbon technologies such as solar thermal and air source heat pumps are only installed in a small proportion of dwellings. These measures have a relatively high cost (approximately £4,500 for solar thermal and minimum costs of approximately £7000 for heat pumps). The model would have prioritised cost-effective measures where applicable and

applying a spending cap meant that these measures are mostly likely to be installed only in dwellings where more cost effective measures are not suitable.

- 4.41 Installation of solid wall insulation only ever occurred in a minority of dwellings. Currently, the capital costs of this measure are still high. For most semi-detached and detached properties the cost of installing solid wall insulation can exceed £15,000; for some terraced housing with only two exposed walls, the cost of the measure may be less, so that it may have fallen below the spending cap, but for the rest of the properties it would not have been an affordable option.
- 4.42 The number of installations increased steadily with increasing budgets up to £50m and then declined slightly in the £100m budget scenario. For the £100 million scenario, this is likely to be the result of an increase in the spending caps and the model including more expensive options in this scenario such as solar thermal panels, solar PV and air source heat pumps.
- 4.43 In order to give an indication of the effectiveness of the targeting, Table 4.24 summarises the numbers of households of different types who are eligible for measures and the percentage who actually receive measures, under different budget scenarios. Five separate household types are shown, defined according to their vulnerability, income status and whether they receive means tested benefits.
- 4.44 As Table 4.24 illustrates, in each of the scenarios the household type receiving the highest proportion of measures were households on incomes below the income threshold with additional vulnerabilities and in receipt of means tested benefits - 16 per cent (or 19,335 homes) received measures in the £10 million scenario compared with 54 per cent (or 86,118 homes) in the £100 million scenario.
- 4.45 The 'leakage' rate – i.e. the number of households that are eligible but not in the target group – increased for higher levels of investment. The group of households above the low income threshold and without any additional

vulnerability but on qualifying means tested benefits received measures only under the scenarios with the highest budgets - for the £100 million scenario 33 per cent of this group received measures, representing 1,227 households.

4.46 Low income households with no additional vulnerabilities received no measures in the £10m or £20m annual budget scenarios, but did receive measures for the £50m and £100m annual budget scenarios. For the £100M scenario, 31 per cent of low income households with no additional vulnerabilities received improvements. This represents a maximum of approximately 4,541 homes.

Table 4.24: The proportion of low income and vulnerable households receiving measures by budget scenario

Type of household		Total number of hhlds	Proportion of households in group receiving measures			
			£10 million	£25 million	£50 million	£100 million
Target Group (relative low income and vulnerable)	In receipt of MTB	158,477	12%	16%	29%	54%
	Not in receipt of MTB	5,972	4%	45%	55%	65%
Eligible but outside target group	Below income threshold, not vulnerable, on MTBs	14,424	0%	0%	24%	31%
	Above income threshold, vulnerable, on MTBs	52,615	3%	16%	20%	28%
	Above income threshold, not vulnerable, on MTBs	3,737	0%	0%	19%	33%

4.47 Table 4.25 shows the average reduction in energy bills for the groups eligible for measures and shows the average bills paid by the group as a whole, not just those receiving measures. The model estimates that the 'target' groups had the highest bills of all those eligible for the scheme, but also experienced the most pronounced change in bills after the energy efficiency measures had been applied (as detailed above in Table 4.24), and, within the 'target' groups, particularly the low income, vulnerable

households in receipt of means tested benefits. In the £100 million scenario low income, vulnerable households in receipt of means tested benefits saw an average reduction of £155 in their annual bills. For the smaller group of low income vulnerable households not in receipt of means tested benefits, the average reduction in annual bills was greater than £200. This change was not so pronounced for the three ‘eligible’ groups. As demonstrated in Table 4.25, for households with incomes above the low income threshold, estimated annual reductions were between £33 and £59.

Table 4.25 Impact on average annual energy bill by household type - all eligible households (not only those receiving measures)

Type of household		Initial average energy bill	Average energy bill after measures have been installed by scenario			
			£10 million	£25 million	£50 million	£100 million
Target Group (relative low income and vulnerable)	In receipt of MTB	£1,513	£1,474	£1,451	£1,438	£1,408
	Not in receipt of MTB	£1,620	£1,619	£1,479	£1,461	£1,416
Eligible but outside target group	Below income threshold, not vulnerable, on MTBs	£1,277	£1,277	£1,277	£1,146	£1,136
	Above income threshold, vulnerable, on MTBs	£1,157	£1,150	£1,118	£1,112	£1,098
	Above income threshold, not vulnerable, on MTBs	£921	£921	£921	£904	£888

4.48 Table 4.26 shows the estimated change in average SAP score for the different groups for each of the scenarios. Under the £100m scenario, the scheme reaches 54 per cent of those households with a low income, an additional vulnerability and in receipt of means tested benefits, improving the average SAP score by approximately 6 points. For the smaller group of low income vulnerable households not in receipt of means tested benefits, the average SAP rating increased by 10 points. For the other three eligible groups lying outside the target group (“Below income threshold, not vulnerable, on MTBs”, “Above income threshold, vulnerable, on MTBs” and

“Above income threshold, not vulnerable, on MTBs”) the changes are less pronounced.

Table 4.26: Impacts on average SAP rating by household type - all households

Type of household		Initial average SAP rating	Average SAP rating after measures have been installed by scenario			
			£10 million	£25 million	£50 million	£100 million
Target Group (relative low income and vulnerable)	In receipt of MTB	52.5	53.9	54.8	56.3	57.9
	Not in receipt of MTB	43.9	43.9	50.7	52.2	53.0
Outside of target group but eligible	Below income threshold, not vulnerable, on MTBs	54.6	54.6	54.6	58.0	58.5
	Above income threshold, vulnerable, on MTBs	57.5	57.9	59.3	59.6	60.2
	Above income threshold, not vulnerable, on MTBs	58.2	58.2	58.2	60.0	60.8

4.49 Overall, the results indicate that as the scheme annual budget increases from £10m to £100m the number of the target group receiving measures (low income with additional vulnerabilities) increased substantially. For low income, vulnerable households in receipt of means tested benefits the proportion receiving measures ranged from 12 per cent in the £10 million scenario to 54 per cent in the £100 million scenario. For low income vulnerable households not in receipt of means tested benefits, the proportion benefiting from the scheme increased from 4 per cent for the £10 million scenario to 65 per cent for the £100 million scenario.

4.50 Some households outside the target group also receive measures. However, the model results suggest that the recommended eligibility

criteria for each budget would allow the target group to receive between 76 per cent¹¹ and 91 per cent¹² of the measures.

¹¹ Proportion of target group receiving measures under £25 million scenario, as reported in Table 4.16 and Paragraph 4.18.

¹² Proportion of target group receiving measures under £10 million scenario, as reported in Table 4.14 and Paragraph 4.12.

5. Conclusions and recommendations

Identifying the target group

- 5.1 The evidence review identified a reasonable level of consensus in the literature that **certain households are more vulnerable than others** to living in a cold home, both in terms of their **likelihood** of living in a cold home and their **susceptibility** to the harmful effects of living in a cold home. Harmful effects can include effects on health and wellbeing, educational attainment and social participation.
- 5.2 The characteristics of households or household members identified as vulnerable were: **older adults** (aged 65 years or over), **children** (particularly aged less than 5 years), **disabled people** and people with **long term limiting health conditions**, most notably those with **respiratory** or **circulatory diseases**, and those with **mental health conditions**. The evidence supports the use of low income plus one or more of these additional markers of vulnerability as eligibility criteria.
- 5.3 The research was particularly focused on low income households with additional characteristics or **markers of vulnerability**, and on understanding the overlaps between these different vulnerabilities. Low income households are more likely to struggle with bills and are more likely to under-heat their homes or go without other essentials in order to manage their finances. They are the least likely to be able to afford to pay for improvements to the efficiency of their homes. The analysis found that households with markers of additional vulnerability are disproportionately represented amongst the lowest income deciles in Wales.
- 5.4 The research considered various ways of defining low income, and selected a definition of relative low income, whereby households are deemed to have a low income if their combined household income is lower than 60 per cent of the median income in Wales.
- 5.5 Amongst the 240,000 households in Wales estimated to be on incomes below the low income threshold, 14 per cent included children (aged under 18 years), 30 per cent an older person (aged 65 years or over) and 43 per

cent included at least one person with a disability or long term illness. Overall, approximately 161,000 (or 67 per cent) of low income households were found to have additional vulnerabilities to living in cold homes. However, there was also some notable overlap between these different groups with around 61,000 low income households estimated to have more than one additional vulnerability marker. For instance, almost two thirds of low income households comprising older people and around one third of low income households with a dependent child also included a household member who was disabled or had a long term illness.

Recommendation – definition of low income

- 5.6 It is recommended that any future scheme use the **before housing costs** definition of relative low income, whereby households are deemed to be in poverty if their **income is lower than 60 per cent of the median income**. This aligns with wider poverty definitions and takes into account household composition. The ‘before housing costs’ definition is recommended because it is simpler to use than the ‘after housing costs’ measure, since the ‘after housing costs’ definition would require additional verification of the annual housing costs of households. It is recommended that household income equivalisation is carried out using six household types; this will simplify the equivalisation process whilst allowing an appropriate level of differentiation to be made between households containing different numbers of adults and children.

Recommendation – markers of additional vulnerability

- 5.7 A future energy efficiency scheme should target households with a relative low income and at least one of the following markers of additional vulnerability:
- older people (people aged 65 years and over)
 - children (particularly children aged less than 5 years),
 - disabled people;

- people with long term limiting health conditions (people with respiratory, circulatory or mental health conditions)

5.8 Further work is recommended to decide which mental health conditions and of what duration should qualify. It is also recommended that additional consideration is given to designing a scheme that engages appropriately with people with mental health problems, being sensitive and taking particular care when assisting them through the process of demonstrating their eligibility and through the installation process.

Identifying, targeting and demonstrating eligibility

5.9 The study considered various approaches for identifying and targeting eligible households. Such systems must take into account various considerations, including administrative cost, targeting efficiency, the available methods for reaching and engaging eligible people and the journey the recipient takes through the process, including the process of demonstrating eligibility.

5.10 A process for targeting eligible households must be designed to achieve a high **targeting efficiency** in order to reach low income households with additional vulnerabilities at a reasonable cost. Improved accuracy tends to come with increased financial cost and to impose increased burdens on the scheme's intended target group.

5.11 Five options were considered, with particular consideration given to the ability of systems to reach those with certain health conditions. These options were as follows:

- to flag households through data matching of housing and income data;
- a self-qualification system with partial, retrospective verification;
- a self-qualification system with full validation;
- the use of third party referral organisations;
- the creation of a bespoke means tested approach specifically for the scheme;

- 5.12 The use of **data matching** would have significant advantages both practically and in cost terms. The data involved could include various levels of information allowing the identification of the vulnerability markers identified above, with individual address level data held securely by a central data repository. This is likely to be a complex and initially costly system to develop and requests for data would therefore potentially be subject to an administration fee. Furthermore, although a proposal has been made to create a specific data matching arrangement to assist citizens living in fuel poverty in the UK, it is unlikely to be commissioned within the timescales being considered for a new national energy efficiency scheme in Wales. However, it should be kept in mind that existing datasets and a robust data matching process could produce a process that would allow effective targeting of eligible households in the future.
- 5.13 **Self-qualification referral systems** are part of some existing schemes targeting low income households. It is a potential option for a scheme looking to specifically target those with certain health conditions and would do so with the intention of minimising target costs as well as minimising additional burden on National Health Services. Self-qualification systems can either minimise costs by applying retrospective validation to a sample of recipients or can attempt to more fully validate eligibility before measures are installed. A clear advantage of including some element of self-qualification is that both individuals who are eligible for but not in receipt of benefits and individuals with specific health conditions could receive measures, allowing the scheme to be as inclusive as possible of households with additional vulnerabilities. In minimising the burden of the validation process, self-qualification would also theoretically reduce costs.
- 5.14 A key argument in favour of including some element of self-qualification is that not all households with relative low incomes and vulnerabilities are in receipt of benefits; some are not in receipt of benefits despite being eligible for them. Designing a scheme that relies on the receipt of means tested benefits to prove eligibility would disadvantage such households further. Furthermore, the welfare system is currently undergoing a series of

reforms. The final impacts of these reforms are uncertain and plans made using a means tested benefit approach may have to be re-evaluated in due course.

- 5.15 In practice, however, the Welsh Government will need assurances that the scheme is reaching the most vulnerable households, a certainty that can only arise through people demonstrating their eligibility (or from confidence in third parties' ability to identify or select vulnerable households). In practice, attempting to recover fraudulently claimed funding is also likely to be both impractical and prohibitively costly. Further, it is a requirement of the Welsh Government that an applicant's eligibility can be demonstrated in practice to the scheme manager.
- 5.16 However, for target groups where demonstrating eligibility is a relatively simple matter, including some element of self-qualification in a future scheme is something Welsh Government may wish to consider. Means tested benefits have been recommended as a relatively simple way for eligible households to demonstrate that they qualify for the scheme, as the majority of recipients will fall into the target group (Income below 60% median, with additional vulnerabilities).
- 5.17 As a result of previous use of **means tested benefits** for predecessor schemes, well-tested systems have already been established which have proven successful in targeting vulnerable people and allowing them to effectively demonstrate their eligibility, as found in the recent Warm Homes Nest evaluation. For those in receipt of the relevant benefits, a process of checking incomes, savings and/or their health status has already been performed. This means that a proportion of potentially eligible households already have paperwork to demonstrate their eligibility.
- 5.18 The receipt of some means tested benefits indicates that recipients have one of the proposed additional vulnerability markers. Requiring the receipt of one of these benefits would help a future scheme to narrow the qualifying criteria to focus on vulnerable low income households rather than on all low income households.

- 5.19 However, some households receiving the qualifying means tested benefits will either have incomes above the low income threshold or have incomes below the income threshold but not have an additional vulnerability marker - the modelling results suggest that between 19 and 25 per cent of all households eligible for the scheme would fall into one of these two groups. This 'leakage effect' is a reality of any such targeting scheme.
- 5.20 A **pre-approved third party referral system** would involve agencies that are already working with vulnerable households referring those households they knew were most likely to fit the eligibility criteria for the scheme. This would rely on the expert knowledge of local authorities, health workers, charities and other outreach professionals to recommend people to a scheme based on their knowledge of their client base. A key advantage of this system is that referral agencies will already have gathered evidence relating to some of the issues that would make people eligible, in many cases removing the requirement for additional evidence to be provided. The costs of targeting in this instance would be to perform a referral pre-accreditation process i.e. to assist agencies to update existing systems or to set up any new referral systems required, and to pay for the ongoing administrative costs of making referrals. It is recommended that this system, or a version of it, is explored and used in the targeting of a future energy efficiency scheme. Furthermore, all agencies approved to administer such a referral process should also be provided with the means and appropriate publicity materials to raise awareness of the scheme among vulnerable households.

Recommendation – Identifying, targeting and demonstrating eligibility

- 5.21 Considering the merits and disadvantages of the approaches discussed above, it is recommended that the Welsh Government consider a combination of options that together represent an advance on current practice:
- where possible, using the **receipt of means tested benefits** to build on existing established systems to allow households to demonstrate their eligibility for the scheme – in doing so, the Welsh Government

should accept that a 'leakage rate' of around 30% will result, allowing some households to receive measures when they either have incomes above the low income threshold or have incomes below the income threshold but no additional vulnerability marker;

- using some element of **self-qualification** involving the referral by the scheme to a **third party** for households where eligibility is complex to evidence; and
- using a **pre-approved third party referral system** that allows those with relative low incomes and certain health conditions but who are not receiving means tested benefits to be included.

5.22 In order to narrow its focus to vulnerable low income households, we would recommend that the following benefits (and additional qualifying criteria e.g. presence of a household member aged 65 years or more, where relevant) be used as a method for households to demonstrate their eligibility:

- **Pension Credit** (low income, pension age adults);
- **Child Tax Credit** (low income households with children);
- **Income related Jobseekers Allowance** plus demonstrating responsibility for children (e.g. in receipt of **Child Benefit**)
- **Employment Support Allowance** (and all previous iterations of it, including but not limited to **Incapacity Benefit**, **Income Support** paid because of illness or disability, **Severe Disablement Allowance** (SDA)), and **Universal Credit**.

Publicising the scheme

5.23 It is recommended that all agencies and networks involved in any pre-approved third party referral option should be enlisted to help publicise and promote the new scheme. Ideally, they should assist with a programme of marketing and outreach through their existing channels with the aim of encouraging as many vulnerable households as possible to participate in the scheme.

Recommendation – publicising the scheme

- 5.24 In order to ensure a satisfactory level of engagement with vulnerable people, a wide range of agencies and networks should be enlisted to help promote any new scheme.

Estimating the impact of different budget scenarios

- 5.25 The main focus of the modelling aspect of the Study was to assess the potential impacts of varying the annual budget, and widening the eligibility criteria accordingly, for a scheme that fully funded whole house retrofit of privately owned or private rented dwellings with low energy efficiency ratings.
- 5.26 The modelling results suggest that, even for the lowest annuals scheme budgets, significant improvements can be achieved in some of the most inefficient dwellings while reducing the numbers of the most vulnerable people who are living in cold homes.
- 5.27 With an annual budget of £10 million over five years, an estimated 21,400 households would receive measures, with around 19,600 of these homes inhabited by low income vulnerable people - this scenario had the highest targeting efficiency rate of 90 per cent. On average, households would receive £2,400 worth of measures which would reduce their annual energy bills by an average of £319. The number of F and G rated dwellings in the eligible group was estimated to more than halve (from an initial 6,900 to 3,300) and 9,800 homes would be improved to a D rating.
- 5.28 Increasing the annual budget to £25 million allowed close to an estimated 37,000 households to receive measures with a targeting efficiency rate of 76%. Households on average received £3,403 of improvements and their bills were reduced by £354. The proportion of dwellings rated F or G was reduced from 31 per cent to 11 percent, homes rated D increased from 0 to 61 per cent, and 1 per cent of homes improved to a SAP rating of C.
- 5.29 Under an annual budget of £50 million, over 63,000 households were estimated to receive measures with a targeting efficiency rate of 77%. Households on average received £3,950 of improvements and their bills

were reduced by £371. The proportion of F and G rated properties was reduced from 36 per cent to an estimated 11 per cent, a decrease of over 15,700 homes and the number of E rated properties decreased by 15 per cent. By the end of the five year programme, this scenario resulted in over half of the targeted dwellings (32,500) having a D rating and an additional 1,900 homes being rated C.

- 5.30 Increasing the annual budget to £100 million resulted in over 110,000 households receiving measures with a targeting efficiency rate of 81%. Households on average received £3,010 of energy efficiency improvements and their bills were reduced by £279. The £100 million scenario widened the eligibility criteria to include SAP band D, resulting in greater improvements in SAP rating compared with the other scenarios: after five years only 6 per cent of properties remained in bands F and G and 76 per cent of properties were in band D or above.
- 5.31 For all budget scenarios, the benefits of allowing a greater expenditure on the most inefficient homes were illustrated. Higher spending caps for F and G rated properties resulted in greater improvements in energy performance and bill savings for households. This highlights the potential benefit of concentrating a greater level of resource to the coldest or most inefficient homes. It is recognised that it may prove difficult to reach target households in F and G rated dwellings in more rural areas but working with third party referral agencies in these areas and providing additional resources to more rural local authorities could be beneficial.
- 5.32 The results suggest that spending caps in each dwelling would ensure that the most cost effective measures are installed wherever these are suitable. However, increasing spending caps for dwellings with lower SAP ratings would allow less conventional energy efficiency measures to be installed where needed. Higher spending caps for lower SAP rated properties would allow a proportionally larger resource to be focused on improving the coldest or most inefficient homes occupied by low income households with additional vulnerabilities.

Recommendations – future energy efficiency scheme budget

- 5.33 The level of total funding available should be used to guide the choice of eligibility criteria, particularly if lower levels of funding are available.
- 5.34 For annual funding of £50 million or less, it is recommended that homes rated E, F or G are the focus of energy efficiency improvements. The intention should be to move dwellings with E, F and G SAP ratings up to D or above. If larger amounts of funding are available, the eligibility criteria should, while maintaining the focus on low income vulnerable households, be widened to include D rated properties.
- 5.35 The scheme should make particular efforts to publicise the scheme and to recruit third party referral agencies working in rural areas.
- 5.36 It is recommended that spending caps should be higher for lower SAP rated properties, allowing a proportionally larger resource to be focused on improving the coldest or most inefficient homes occupied by low income households with additional vulnerabilities.

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Annex A Evidence assessment / Review of existing research and evidence

The primary assessment of risk of living in cold homes and vulnerability to the harmful effects of living in cold homes was performed using a rapid evidence assessment. This is presented in full here. Wherever possible we have included information and metadata on the studies, the data sources or the surveys used where details have been provided in the literature.

Introduction

There is comprehensive evidence to show that living in a cold home has adverse implications for outcomes ranging from health to educational attainment and social participation. Several studies have successfully quantified the health impacts of cold homes, with an annual seasonal rise in deaths known to occur in winter, and a well-documented link between respiratory and circulatory disease and low temperatures. Evidence is also growing to support the case that cold homes can lead to social exclusion, mental health problems and developmental issues.

Although all households have the potential to suffer harmful effects of living in a cold home, there are certain factors that increase the a) likelihood of an individual living in a cold home and b) being particularly susceptible to harmful effects from living in a cold home, and hence of being particularly vulnerable to cold homes. Of particular concern in this review is the subset of people who are both vulnerable to cold homes and who are also struggling with low incomes. This review considers findings from the available literature on the characteristics of households that are most likely to live in cold homes and the reasons for this; what harmful effects are associated with living in cold homes; which individuals or households are particularly susceptible to these effects; and finally, the numbers of low income households with these additional vulnerability characteristics.

This is primarily a secondary analysis of existing research findings and reports (a full bibliography is available at the end of the document), but also presents some analysis of data to test and supplement the findings from the literature.

Annex Table A.1: Vulnerable households or individuals commonly identified in the literature

Vulnerable Groups	NICE ¹³	Ofgem ¹⁴	Public Health England ¹⁵ ₁₆	DECC ¹⁷	Royal Colleges of Physicians ¹⁸
Low income households	✓	✓	✓	✓	✓
Elderly people	✓	✓	✓	✓	✓
Young people	✓		✓	✓	✓
People with disabilities or long term illnesses	✓	✓	✓	✓	✓
People with mental health conditions	✓	✓	✓	✓	
Households living in Inefficient Housing		✓	✓		✓
Ethnicity (BME households)		✓			

Finally, it is important to note that whilst in much of the literature ‘fuel poverty’ is used as a proxy for living in a cold home, these are not synonymous terms. The issues from each situation may overlap and be related, but they are not interchangeable. Where a study has referenced vulnerability to ‘fuel poverty’ rather than ‘cold homes’, we have used this term rather than translate – and therefore potentially shift – the focus of the findings.

Summary findings

It is well accepted that certain types of individuals or households are more vulnerable to the harmful effects of living in a cold home (Department of Energy and Climate

¹³ (NICE, 2015)

¹⁴ (Ofgem, 2013)

¹⁵ (Public Health England, 2013)

¹⁶ (Public Health England, 2014)

¹⁷ (Department of Energy and Climate Change, 2014)

¹⁸ (Faculty of Public Health of the Royal Colleges of Physicians of the United Kingdom, 2006)

Change, 2015a). The groupings which form the focus of attention in this report (and discussed in more detail in Section 4) were selected on the basis of their repeated identification through the literature as at increased risk of vulnerability. The groups that are commonly mentioned in the literature are shown in Annex Table A.1, against a set of key studies, in which the vulnerability of certain groups of the population is identified. (The green colouring signifies where the literature has identified a particular group as being at increased risk of vulnerability.)

While there are many separate and inter-related reasons why certain groups may be more likely to live in a cold home, there are two common strands for all these households: they include vulnerable household members and have lower than average household incomes, and they are at greater than average risk of living in energy inefficient homes.

Households most likely to be living in cold homes

Low Income households

It has been repeatedly proven that there is no simple link between living in a cold home and deprivation or low income. This is down to a number of factors, in particular the fact that low income households are more likely to live in social housing, which tends to be more energy efficient (Hajat, Kovatz and Lachowycz, 2006). However, living in a more energy efficiency home does not mean that the occupants will feel warm: many on the lowest incomes will still find their energy bills unaffordable and cut back on heating to manage this. In addition, not all low income households live in social housing and those living in typically less efficient privately rented or owner occupied housing will need to consume more energy to maintain adequate levels of warmth.

Some evidence has demonstrated a link between specific factors, such as debt or unemployment, and living in cold homes. Children in families with debts, for instance, have been shown to be three times more likely to live in a cold home at some point, and a further 1.5 times more likely to live in a cold home on a persistent basis

(Barnes, Butt and Tomaszewski, 2008).¹⁹ In Ireland, 65 per cent of households with an unemployed person at their head are fuel poor, compared to just 13 per cent amongst those with an employed head of household (Public Health Policy Centre, 2007)²⁰. The LiW survey data estimates that 46 per cent of workless households were in fuel poverty in 2008, compared to just 10 per cent of households where all working age adults were in employment (LiW, 2008). A wider European study also identified that those out of work, or in very low income jobs, were particularly likely to be in energy poverty (Bouzarovski, 2014). Work by the Centre for Sustainable Energy (CSE) also found that very low income households (those earning less than £6,000 per year) were likely to be struggling to keep up with bills and commitments, had found bills to be a heavy burden and had cut back their spending on fuel (Centre for Sustainable Energy, 2010)²¹. Analysis of the National Survey of Wales shown in Annex Table A.2 illustrates that most households struggling to keep up with their bills, and over 90 per cent of households who have fallen behind with payments, are in material deprivation.

Annex Table A.2: Households ability to keep up with household bills and rates of material deprivation.

Ability of households to keep up with bills and credit commitments	Proportion of households in material deprivation
Keeping up with all bills and commitments without any difficulties	5%
Keeping up with all bills and commitments but it is a struggle from time to time	25%
Keeping up with all bills and commitments but it is a constant struggle	56%
Falling behind with some bills or credit commitments	93%
Having real financial problems and have fallen behind with many bills or credit commitments	92%

Source: National Survey for Wales 2014-15

¹⁹ Uses data from the FACS survey which tracked the same families between 2001 and 2005. Persistent is used to describe cases where the child was found in bad housing for 3, 4 or 5 of the annual observations.

²⁰ Based on data from 2004 Interim House Condition Survey, in which 2,300 inspections were carried out of properties across Ireland.

²¹ Uses data from a survey involving face to face interview of 699 low-income households in Great Britain in fuel poverty

Additionally, when low income households live in sub-standard, inefficient housing, it is likely that they will be affected more acutely than families with higher incomes, as they will be faced with stark choices on where to spend their limited income. In particular there is evidence from a national evaluation that the “heat or eat” dilemma is faced by low income families in cold homes. The evaluation of Warm Front, a UK government scheme designed to improve the efficiency of homes, found that 10 per cent of families who had made savings as a result of the scheme felt able to purchase “more and better quality food” in greater volumes (Marmot Review Team, 2011).²² This is supported by research in the U.S.A., as reported in the Fuel Poverty Review, which identified a link between fuel costs and food consumption, with families spending proportionally less on food during cold weather to balance the increased spending required on fuel. This was estimated to equate to an average reduction in calorific intake of around 200 calories, per person per day, during winter months (Marmot Review Team, 2011).²³

Finally, a relationship also exist between low income and health outcomes, as recorded by average life expectancy: in the most deprived 10 per cent of lower level super output areas (LSOA) in England the life expectancy is 9.2 years lower for males and 6.8 years lower for females than in the least deprived LSOAs (ONS, 2014).

The numbers of low income households in Wales has been derived from the Households Below Average Income (HBAI) dataset²⁴. Overall, 29 per cent of households in Wales have an income which is 60 per cent or lower than the median income in the UK – the threshold of relative poverty. The data allows some analysis of the levels of poverty experienced by groups of households with different socio-economic characteristics, including tenure, disability, economic status, household

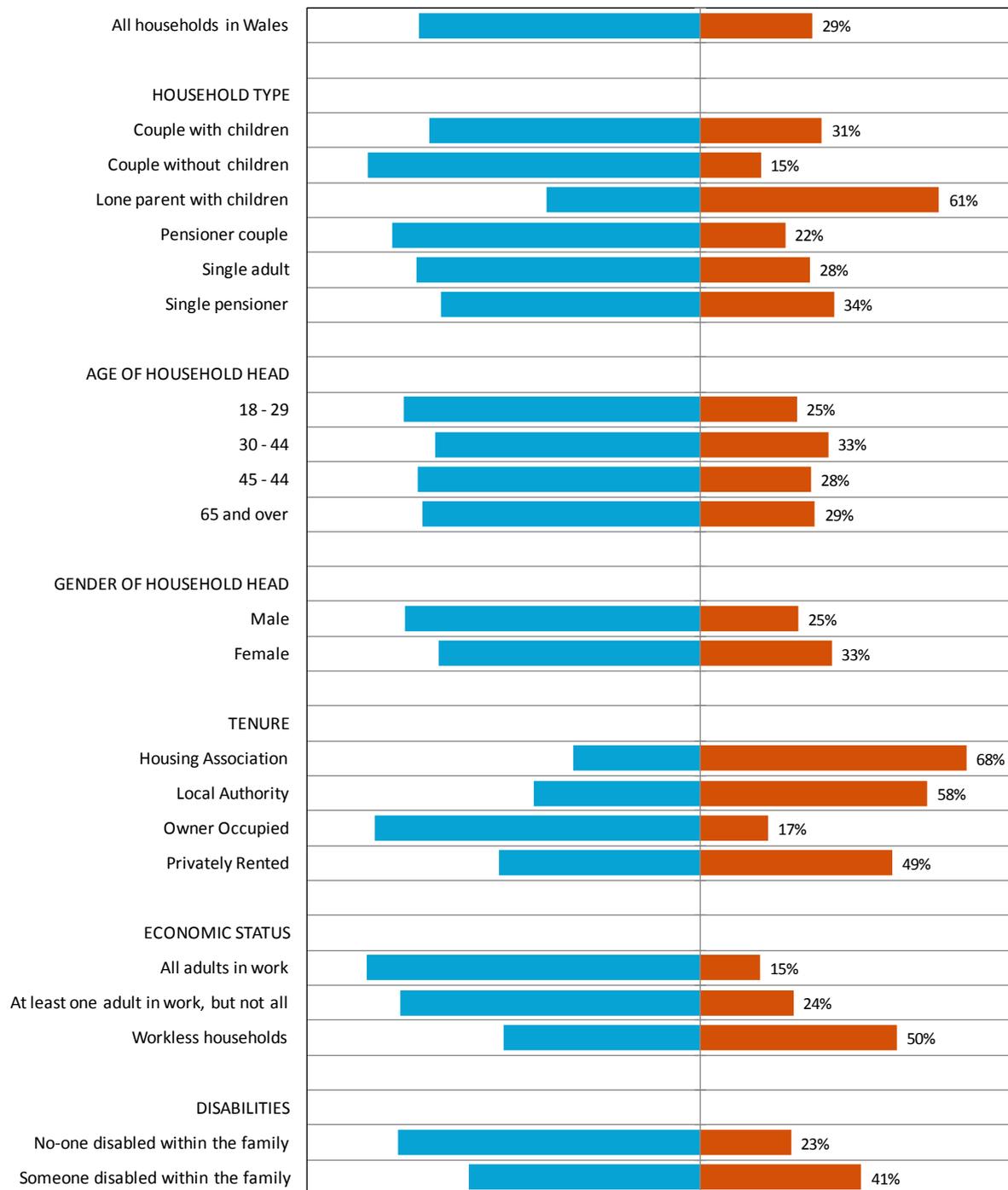
²² Warm Front health impact evaluation involved semi-structured interviews with 49 households who received home energy improvements under the scheme, within 5 areas.

²³ Uses data from Consumer Expenditure Survey (1980-1998, which collected data from 5,000 households every month, with 104,747 households in the final sample) and the third National Health and Nutrition Examination Survey (1988-1994, including data from 33,994 people)

²⁴ Department for Work and Pensions. (2015). *Households Below Average Income, 1994/95-2013/14*. [data collection]. *8th Edition*. UK Data Service. SN: 5828, <http://dx.doi.org/10.5255/UKDA-SN-5828-6>.

type, age and gender of the head of the household. In summary, analysis of the HBAI data indicates that poverty disproportionately affects the following groups: those living in rented accommodation (particularly social housing), households where no one is currently working, households with disabled people, those with a female as head of the household, and particularly lone parent mothers (where over 60 per cent of households were living in poverty).

Annex Figure A.1: Profile of low income households in Wales by household type, age of head of household, gender of head of household, tenure, working status and disability (Source: Households below average income (HBAI) 2013-



Other socio-economic factors

Age UK estimated that there are 4.5 million older people living in fuel poverty in the UK (Age UK, 2012). More recent ONS data finds that median household incomes amongst retired households is higher than amongst non-retired households (ONS, 2015), which raises some questions about the increased likelihood of older people living in fuel poverty. However, there are a number of explanations for understanding why older people are identified as at above average risk of living in a cold home. One explanation concerns under-occupancy amongst retired households, with many older people, including older people who live alone, living in large homes that are costly to heat (Centre for Ageing Research and Development in Ireland, 2014).

In the UK, 930,000 families with 1.6 million children, were estimated to be in fuel poverty in 2013 (ACE, 2013). A subsequent survey suggested that 28 per cent of children (1.3 million) in the UK thought their home was too cold (The Children's Society, 2014)²⁵. Children living in certain household types including single parent households, low income households, households in rural areas. Children with a black or other ethnic minority parent and children with a long term illness are also identified as at particular risk of living in a fuel poor home (National Children's Bureau (NCB), 2012).

The Hills review (CASE, 2012) estimated that 34 per cent of fuel poor households included someone with a disability or long term health condition (compared to 18 per cent of the general population)²⁶. A review of DECC statistics (between 2003 and 2010) found that 20 per cent of households which included at least one person with a disability or long term illness were in fuel poverty, compared to 15 per cent amongst other households (George, Graham and Lennard, 2013). It is worth noting that such statistics may understate rates of fuel poverty affecting disabled people. This is because disability benefits, paid to cover additional living costs borne by disabled people, are counted as income in the fuel poverty calculations. This means such households are identified as having an inflated income and so are less likely to be

²⁵ Based on a survey of 2,000 children in the UK

²⁶ Based on results of the 2011 census

identified as being in fuel poverty than comparable households which do not include a disabled person (George, Graham and Lennard, 2013). A survey commissioned by the Citizens Advice Bureau indicated that more than half of respondents who self-identified as disabled people reported having had to make a choice between heating and eating (Disability Action, 2011).²⁷

Several reports suggested that black and minority ethnic households were at greater risk than white households of living in a cold home. These reports recognise that treating non-white households as a single group has its limitations. Statistics from the EHS (2009-2011) do show that 29 per cent of BME households live in private rented accommodation, almost twice the rate (15 per cent) of white households living in private rented accommodation. This may increase the likelihood of BME households living in cold homes, as average energy efficiency rates amongst the private rented sector is poor (see below).

Research by the Building Research Establishment (BRE) found that BME households were actually slightly less likely than others to experience category 1 cold²⁸, with 6 per cent of white households experiencing it compared to 4 per cent of BME families. BRE concluded that this was likely the result of the higher energy efficiency ratings of the social rented sector, where a high number of BME households are also found (27 per cent of BME households, as compared to 16 per cent of white households).

A study that used the low income high costs definition of fuel poverty found that 16 per cent of minority ethnic households in England were found to be in fuel poverty, compared with 10 per cent of white households (McFarlane, 2014).²⁹ This measure takes into account income levels and so reflect that the lower than average income of BME households (find statistics) makes heating the home to an acceptable level

²⁷ Based on survey of 368 CAB clients in 2011

²⁸ The Housing Health and Safety Rating System (used by local authorities to assess dwellings) identifies 29 hazards found in the home – excess cold is one of these hazards. When a home is assessed each hazard is given a rating - category 1 is the most serious. If a local authority finds a category 1 hazard in a home they are obliged to take action.

²⁹ Based on data from the EHS 2009-2011. This was a survey of 22,258 households across England.

substantially more difficult. Additionally, the Marmot Review pointed out that children in families with a black or minority ethnic (BME) mother were twice as likely to be in persistently cold homes as other children.³⁰ One factor suggested to be responsible for this was the increased likelihood that these families would have no adult in the household employed for more than 16 hours a week (Marmot Review Team, 2011). Thus the evidence on increased risk of living in cold homes amongst BME households appears mixed and inconclusive, with a need for research to more carefully consider patterns affecting households from different ethnic backgrounds and according to different tenure type and household structure.

Households living in inefficient homes

Clearly an important risk factor for living in a cold home is the energy efficiency of dwellings. In the UK, the efficiency of dwellings is usually measured by the Standard Assessment Procedure (SAP) developed by the Building Research Establishment (BRE) in 1992 and used to assess and compare the energy and environmental performance of dwellings. SAP assessments are used to award EPCs to homes, which include a SAP score between 1 and 100; a low score indicating an inefficient dwelling and a high score representing a high efficiency. SAP scores are used to allocated SAP bands to dwelling between A and G, with A being the most efficient band and G being the least efficient³¹.

Inefficient homes are disproportionately found in rural areas, and thus people living in these areas have an increased likelihood of living in a cold home (National Energy Action, 2013a). Estimates by the Welsh Government suggest that 42 per cent of homes in rural areas are in fuel poverty, compared to just 22 per cent of those in urban areas (National Assembly for Wales, 2011). Properties in the private rented sector have the highest incidence of poor energy performance ratings: 13.5 per cent of properties are rated in the lowest two SAP categories (British Property Federation, 2013). The Department for Energy and Climate Change's (DECC) annual report on fuel poverty in 2015 also showed that private rented properties were the most likely to have occupants in fuel poverty (19 per cent of private rented tenants in England

³⁰ Based on the FACS survey

³¹ www.gov.uk/guidance/standard-assessment-procedure

are in fuel poverty compared to a national average of 11 per cent, according to the Low income, high costs (LIHC) definition). One explanation for this poor performance of dwellings in the private rented sector is that landlords are less likely to value the benefits of making energy efficiency improvements. This is dubbed as the tenant-landlord problem: with the issue being that the party who pays is not the same as the party that benefits, creating an incentive mismatch (Ambrose, 2015). Evidence from the KWILLT (Keeping Warm in Later Life) project also shows that there is a fear amongst private tenants of requesting energy efficiency improvements in case they suffer eviction or rent hikes as a repercussion (Allmark and Tod, 2014).³²

The DECC statistics also show, however, that the average SAP rating of private rented properties is 58.8, almost identical to that of owner occupied properties, which have an average rating of 58.7. Although owner occupied properties have similar SAP ratings to private rented properties, the average income of owner occupiers is higher (a median equivalised AHC income³³ of £24,657 compared to £15,047 for private rented properties). As a result the incidence of fuel poverty is only 8 per cent in owner occupied properties (Department of Energy and Climate Change, 2015b). This somewhat undermines the 'tenant-landlord' theory, as owner occupiers do have an incentive for improving the quality of their own home.

According to a report by CSE, 54 per cent of tenants of private landlords reported that their home was colder than they would have liked during the previous winter (Centre for Sustainable Energy, 2010).³⁴ Research carried out by NatCen also found that 14 per cent of children living in privately rented accommodation lived in homes that were inadequately heated (according to their parents), compared to 2 per cent living in owner occupied properties (Barnes, Butt and Tomaszewski, 2008).³⁵ These studies which draw on subjective responses regarding warmth are less reliable than studies that use clinical markers or objective measurements of cold.

³²Based on survey conducted in Rotherham, 50 interviews with older people and 25 interviews with health and social care professionals.

³³ After Housing Cost income

³⁴ Based on questions included in the NatCen consumer omnibus survey in 2009. This included face-to-face survey of 2,708 individuals across Great Britain.

³⁵ Based on data from the FACS (1999-x) including interviews with 7,657 families

The impact of living in cold homes

Every winter there is an increase in deaths when compared to an equivalent period in summer (NatCen, 2015). These additional fatalities are known as Excess Winter Deaths (EWD); the National Institute for Health and Care Excellence (NICE) guidance suggests, on average, that there are 24,000 EWD in England and Wales annually (NICE, 2015). This number varies from year to year, however, with milder winters bringing fewer deaths. For instance, in 2014-15 there were 44,000 EWD deaths, the highest figure in the last 15 years.³⁶ Contrary to popular belief, these deaths are not usually attributable to hypothermia or exposure to extreme cold, but are mostly likely to be the product of creeping respiratory and cardiovascular problems (The Strategic Society Centre, 2013).

The Hills Review estimated that 10 per cent of EWDs could be related to living in cold homes, a number which has been suggested by some to be too conservative (Hills, 2012). Living in cold homes has been linked to a range of health problems, with circulatory and respiratory diseases and mental health problems those most commonly linked to under-heated housing (Care Services Improvement Partnership (CSIP), 2014) (Long et al., 2015) (Marmot et al, 2013).

When temperatures drop in winter everybody feels the impact. Nevertheless, for those living in the very coldest homes the impact on mortality is much more severe. a 1°C drop in external temperature is associated with a 0.9 per cent increase in the death rate for those living in the warmest 10 per cent of homes, compared with a much larger 2.8 per cent rise in deaths for those living in the coldest 10 per cent of homes (NICE, 2015)(Garin et al., 2014).³⁷

Alongside this increased mortality rate, cold winters and cold homes also bring greater morbidity (NHS, 2009). A report found that in North West London, there were 300 more admissions to hospitals every month for cold related illnesses during the winter months when compared with summer months when hospital admissions are

³⁶ <http://visual.ons.gov.uk/excesswintermortality/>

³⁷ Uses mortality statistics coupled with data on housing conditions from EHCS 1991 – 21000 dwellings. Evidence of 80,331 deaths from cardiovascular disease in England 1986-89, linked by postcode of residence to data in EHCS, 1991.

approximately 2,300 per month (Brent Council, 2011). It has also been estimated that for every EWD that occurs in a winter, there is also likely to have been 8 additional emergency admissions from the wider population (Department of Health, 2007). The total cost to the UK National Health Service (NHS) of all illnesses likely to be caused by cold homes has been estimated to be £1.36 billion every year (Age UK, 2012). Subsequent research by BRE has estimated the costs of excess cold³⁸ to be £848 million per year. This is the single greatest cost to the NHS of any hazard identified in housing (Nicol, Roys and Garrett, 2015).

It has been suggested that 15-33 per cent of all EWDs are the result of respiratory diseases, which include any condition acting upon our air passages and ability to breathe (WHO, 2011) including both acute and chronic, long lasting conditions (Housing New Zealand et al, 2008) (Vries and Blane, 2013). It is thought to be the case that when temperatures fall below the level of 16°C resistance to respiratory disease decreases (Lacroix and Chaton, 2015). Alongside low temperatures, the increased likelihood of damp and mould in cold homes also makes the occurrence of respiratory problems greater (Webb et al., 2013). A study by Fisk et al found that the presence of dampness and mould in a building was associated with a 30-80 per cent rise in a variety of respiratory and asthma related outcomes (Canterbury District Health Board, NZ, 2012).³⁹

Chronic Obstructive Pulmonary Disease (COPD) is an encompassing term for a collection of lung diseases that are commonly linked to both indoor and outdoor cold exposure. A cross sectional study was carried out of 148 COPD sufferers (Ormandy and Ezratty, 2012) in Aberdeen. The findings suggested that when indoor temperatures were not maintained at 21°C for at least 9 hours of the day that symptom scores for respiratory health declined significantly. Cold temperatures reduce lung function which can trigger COPD, alongside other common conditions, such as asthma.

³⁸ Excess Cold is one of 29 hazards identified in the Housing Health and Safety Rating System, which is a risk based evaluation tool to help local authority identify and protect against risks in dwellings.

³⁹ Based on a meta-analyses

Circulatory, or cardiovascular, disease includes all diseases linked to the heart and circulatory system. In 2001, the UK Fuel Poverty Strategy reported that circulatory disease was responsible for half of all excess winter deaths (Threlfall, 2011). Deaths from Cardiovascular disease are 22.9 per cent higher in winter months than in summer months (Public Health England, 2014). Another report puts this figure at 50-70 per cent (WHO, 2011). Temperatures below 12°C are known to strain the cardiovascular system. The coldness causes a narrowing of the blood vessels, and an increase in the thickness of the blood which can put people at greater risk of heart attack (Lacroix and Chaton, 2015) (Howden-Chapman, 2002) (O’Sullivan et al., 2011).

Extended time spent living in a cold home has been shown to influence mental health as well as physical health (National Energy Action, 2013b). The pre-existence of mental health problems is a risk factor that makes a certain group of people more vulnerable to the stresses of cold homes; as discussed in a later section. Additionally, living in a cold home can be a depressing experience that may trigger mental health issues. Indeed, those living in cold housing were found in a report by the UK Chief Medical Officer to experience three to four times the level of mental health problems (Lemer et al, 2013).

Experiencing cold and damp conditions on a daily basis can be depressing and persistence of physical illness is a dispiriting experience. One statistic suggests that sleeping in a bedroom with a temperature of 15°C increases the likelihood of depression and anxiety by 50 per cent, compared to those with a bedroom at a temperature of 21°C (Department of Health, 2007).⁴⁰ Alongside the stress brought by the physical conditions, the worry caused by financial strain is also important. A Scottish study found that those people who struggled to pay their utility bills were 4 times more likely to be anxious and depressed than those who experienced no such difficulty (Scottish Government, 2012). More indirect impacts of cold homes on mental health include the knock-on impact of overcrowding on social functioning within the home. A common coping strategy is to heat one room and spend the

⁴⁰ Warm Front health impact evaluation (2006): involved semi-structured interviews with 49 households who received home energy improvements under the scheme, within 5 areas.

majority of their time in there. However, overcrowding has been linked to aggression, conflict and mental health problems (Environment Canterbury, 2013). A cold home may also impact on relationships outside of the home, as individuals may become more reluctant to invite friends round and may fear the cost of going out, leaving them socially excluded (Centre for Sustainable Energy, 2014)(Public Health England, 2015). Additional stressors include damage to property through cold and damp, fear of debt, stigma and social isolation (Liddell and Guiney, 2015).

Improvements to mental health have been shown to be possible through home energy efficiency improvements (Shortt and Rugkåsa, 2007) (Environment Canterbury, 2013). A study monitoring the impact of interventions such as heating installation and window repair looked at the impact it had on the mental health of the occupants. The impacts of the study concluded there was consistent evidence linking cold and damp homes with mental well-being (Liddell and Guiney, 2015).

Vulnerable groups most affected by living in cold homes

Through the literature reviewed, several groups of households were commonly mentioned as being the most vulnerable to living in cold homes, most notably for being the most susceptible to the physical and mental health impacts outlined in the previous section. Here we explore these vulnerabilities in more detail and, using data from the Living in Wales (LiW) Survey 2008, provide some data analysis of each group's income distribution, energy efficiency status, fuel bill and average fuel poverty ratio.

After identifying these groups, the section also provide some further analysis of the income distribution of each group using more up to date income data and different income types. The section concludes with an analysis of low income households who experience several of the vulnerabilities mentioned.

Older people

Older people are particularly susceptible to the harmful effects of cold homes. Explanations for why older people are particularly susceptible have been framed as a "clustering of vulnerabilities" (UK Health Forum, Friends of the Earth and the

Energy Bill Revolution, 2013), including: a physiological disposition to suffer from the cold; greater incidence of chronic disease; a greater likelihood of living in a cold home and spending more time inside it; and social situations increasing the likelihood of being impacted by a cold home.

Most strikingly, the over 85s account for 48 per cent of EWDs, 28 per cent being experienced by 75 to 84 year olds and the remaining 24 per cent occurring in the under 75 age group (Sharpe et al, 2015).

Issues with thermo-regulation, the ability to create and maintain a stable body temperature, are the first physiological factor that may increase the risk for older people in a cold home. This is down to a lower metabolic rate resulting in generation of less heat in the body, combined with a reduced ability to prevent heat being lost through the skin by narrowing the blood vessels (Day and Hitchings, 2011). The thermo-regulatory system may also be further compromised by drugs being taken to combat other conditions (Rudge and Gilchrist, 2007). When people age, the subcutaneous fat layer of the skin also thins and has reduced levels of insulation, which in turn makes older people more susceptible to hypothermia (Marmot Review Team, 2011). A link has also been found in elderly people between lower temperatures and higher blood pressure and blood viscosity, both which are risk factors for Cerebral Vascular Accident (CVA) and heart attack (Lacroix and Chaton, 2015). Although cold temperatures can lead to increased blood pressure for all age groups, amongst older age groups, it remains elevated for a longer period of time after exposure (Age UK, 2012).

Old people are also more likely to have pre-existing health conditions which are exacerbated by cold conditions, including heart problems (Age UK, 2012). and arthritis, which can increase the risk of falls and fall-related injuries (The Housing and Ageing Alliance, 2013).

In addition to the physiological factors associated with ageing, there are additional social factors that make old people more at risk from cold homes Older people are more likely to live in single occupancy, or under-occupied, households. In England

and Wales of those living alone, 59 per cent were aged 85 and over.⁴¹ As a result they must bear the cost of heating bills solely from their income. Below-average rates of computer-literacy amongst older generations may partially explain why older people are less likely to be on lower energy tariffs and pay over the odds for their energy (Tod et al., 2012). It has been estimated that, on average, older people spend 80 per cent of their time at home (The Housing and Ageing Alliance, 2013) (Islington Council), making them more susceptible to any harmful effects associated with the build quality of their dwelling. However, older people do receive a substantial amount of state aid to help cover their energy bills. All pensioners receive the Winter Fuel Payment and may also be eligible for the Cold Weather payment (not just pensioners) and they also make up the core group for the Warm Home Discount (which could see bill reductions of up to £440 a year). These are all reductions in the cost of energy that other groups, for instance young families, would not be able to access.

Annex Table A.3 and Annex Table A.4 below show the income distribution of households in 2008 containing at least one adult aged 65 or over and at least one adult aged 75 or over, respectively. (The incomes used in this analysis – and subsequent similar analysis of vulnerable households – are net incomes after tax and national insurance deductions.) As is clear from the data, households comprising older people are disproportionately represented in low income deciles, with this trend being more significant amongst people aged 75 and over. 49 per cent of households that include someone aged 65 or above are in the bottom three income deciles (poorest 30 per cent of households), rising to 54 per cent of households that include someone aged 75 or over.

Although average energy costs amongst low income older households are on average lower than amongst wealthier households, the average SAP rating of low income older households was below the national average SAP rating in 2008.

⁴¹ Based on ONS 2011 Census data

Annex Table A.3: Income distribution and energy situation of households where the head of household is 65 years or older

Income decile	All households				HRP 65 or over			
	Average fuel bill (£)	Average SAP rating	Average FP ratio	Number of households	Proportion of group	Average fuel bill (£)	Average SAP rating	Average FP ratio
1	£1,278	50.5	21.4%	55,778	16%	£1,295	48.3	18.8%
2	£1,195	51.4	11.8%	58,881	17%	£1,186	49.3	11.9%
3	£1,311	50.6	10.5%	57,248	16%	£1,281	49.7	10.2%
4	£1,318	51.1	8.8%	47,939	14%	£1,330	49.8	8.8%
5	£1,364	50.5	7.7%	37,190	11%	£1,371	48.6	7.8%
6	£1,481	49.0	7.0%	31,417	9%	£1,605	46.9	7.6%
7	£1,464	51.4	5.8%	21,452	6%	£1,716	50.6	6.9%
8	£1,564	49.8	5.2%	20,076	6%	£1,624	47.2	5.5%
9	£1,648	50.8	4.4%	9,867	3%	£1,521	51.5	4.0%
10	£1,863	48.0	3.4%	8,407	2%	£1,775	46.9	3.2%
All	£1,448	50.3	8.6%	348,255	100%	£1,378	48.9	10.4%

Source: LiW property and household surveys, 2008

Annex Table A.4: Income distribution and energy situation of households where the head of household is 75 years or older

Income decile	All households				HRP 75 or over			
	Average fuel bill (£)	Average SAP rating	Average FP ratio	Number of households	Proportion of group	Average fuel bill (£)	Average SAP rating	Average FP ratio
1	£1,278	50.5	21.4%	24,498	16%	£1,204	49.2	17.9%
2	£1,195	51.4	11.8%	32,987	22%	£1,218	48.7	12.2%
3	£1,311	50.6	10.5%	24,286	16%	£1,303	47.8	10.4%
4	£1,318	51.1	8.8%	22,730	15%	£1,353	53.0	9.0%
5	£1,364	50.5	7.7%	16,060	11%	£1,235	51.2	7.0%
6	£1,481	49.0	7.0%	14,850	10%	£1,514	49.3	7.3%
7	£1,464	51.4	5.8%	7,307	5%	£2,110	51.9	8.5%
8	£1,564	49.8	5.2%	5,974	4%	£1,856	45.6	6.2%
9	£1,648	50.8	4.4%	2,193	1%	£1,375	55.4	3.8%
10	£1,863	48.0	3.4%	689	0%	£1,039	59.3	0.7%
All	£1,448	50.3	8.6%	151,574	100%	£1,350	49.8	10.7%

Source: LiW property and household surveys, 2008

Children and infants (aged less than 5 years)

Studies have indicated that children may be particularly susceptible to the harmful effects of cold homes. Children, particularly infants, may be less able to deal with thermal stress than adults, and, particularly pre-school children are likely to spend a significant amount of their time in the home.

For this group, the evidence of health effects is mainly expressed in terms of morbidity, with an increased incidence of certain health conditions. An observational study in the USA suggested that the prevalence of respiratory problems doubles in groups of children who have lived for at least 3 years in cold homes, compared to those in efficient housing (Liddell, 2008)⁴². A study that analysed UK national survey data similarly found that children living permanently in inadequate housing had double the likelihood of developing respiratory problems, for instance asthma and bronchitis⁴³ (Marmot Review Team, 2011) (Climate Just, 2014).

A large scale study using data from 45 different countries calculated that every year there were 0.07 asthma related deaths and 50 asthma related Disability Adjusted Life Years (DALYs) per 100,000 children that could be linked to dampness, and a further 0.06 deaths and 40 DALYs that could be linked to mould (WHO, 2011).

There are particularly severe implications for the weight gain and development of children living in cold homes since birth. A study in the USA found children in low income families receiving no financial support for their fuel costs were 29 per cent more likely to be underweight than those from low income families who were receiving a winter fuel subsidy.⁴⁴ The explanation for this was that more calories are required to keep warm in winter months but less calories are consumed by children in these families due to lack of income (Liddell, 2008). Slow weight gain in the early years has been linked to educational and development disadvantage that persists far into later life (Heyman et al, 2004).

⁴² A study by NatCen of 14,000 English children followed over the course of 5 years (can't find age)

⁴³ Study by NatCen using data from the FACS (Families and Children study)

⁴⁴ 5-city study, comparing 2 groups of low income children (7,074 children in total) – one receiving a winter fuel subsidy, and one not.

For older children there are also significant social implications of cold homes. Educationally, the increased incidence of asthma and other disease will cause more days to be missed from school, which over extended periods of time can have significant impact upon attainment. In New Zealand it was shown that 15 per cent less days were missed from school once energy efficiency improvements had been made to housing (Liddell, 2008).⁴⁵ A study in Cornwall found similarly that the installation of central heating into damp properties had a significant impact, reducing the number of days missed from school from 9.3 to 2.1 days per 100 (Stewart, 2013).⁴⁶ A common strategy to deal with cold housing is to heat just one or two rooms in the home; however, the result of this is crowding in the heated rooms. The lack of quiet and warm places to study and complete homework for children in cold homes are therefore also pertinent issues (Marmot Review Team, 2011).

Some research has indicated that whilst the implications of cold housing on younger children are mostly physical, in older children and teenagers, the mental health implications are more significant (Shelter, 2006). NatCen conducted an investigation of the mental health impacts of fuel poverty on adolescents which found that more than a quarter of those who had spent extended periods of time in cold homes were at significant risk of mental health issues (Liddell, 2008). Older children living in cold homes are five times more likely to develop mental health problems as their peers in adequately heated homes (UK Health Forum, 2014). These studies posit that the lack of personal space and privacy, and the increased likelihood of spending time outside of the home, are largely to blame for this. Teenagers in cold homes also exhibit greater incidence of truancy and risk taking, for instance smoking and drinking, than those from other households (Liddell, 2008).

⁴⁵ Study of 1,350 households (4,407 individuals). All lived in uninsulated dwellings at the start of the study, and at least one member of each household had a reported respiratory symptom in the past year. Randomly selected households were insulated and outcomes were monitored through questionnaires.

⁴⁶ <http://www.ncbi.nlm.nih.gov/pubmed/11114752> - Study of 72 children with asthma in Cornwall who had central heating installed in their houses.

Annex Table A.5: Income distribution and energy situation of all households with dependent children

Income decile	All households			Households with dependent children				
	Average fuel bill (£)	Average SAP rating	Average FP ratio	Number of households	Proportion of group	Average fuel bill (£)	Average SAP rating	Average FP ratio
1	£1,278	50.5	21.4%	9,572	2%	£1,428	52.6	24.3%
2	£1,195	51.4	11.8%	24,959	6%	£1,291	51.5	12.6%
3	£1,311	50.6	10.5%	28,747	7%	£1,441	51.9	11.6%
4	£1,318	51.1	8.8%	33,093	9%	£1,254	56.4	8.5%
5	£1,364	50.5	7.7%	37,384	10%	£1,555	51.5	8.7%
6	£1,481	49.0	7.0%	40,776	11%	£1,524	52.5	7.2%
7	£1,464	51.4	5.8%	37,757	10%	£1,562	51.5	6.2%
8	£1,564	49.8	5.2%	59,078	15%	£1,755	48.3	5.9%
9	£1,648	50.8	4.4%	56,460	15%	£1,693	53.4	4.5%
10	£1,863	48.0	3.4%	57,713	15%	£1,993	47.7	3.6%
All	£1,448	50.3	8.6%	385,539	100%	£1,614	51.3	7.3%

Source: LiW property and household surveys, 2008

Annex Table A.6: Income distribution and energy situation of households with at least one child under the age of five

Income decile	All households			Households with children under five years of age				
	Average fuel bill (£)	Average SAP rating	Average FP ratio	Number of households	Proportion of group	Average fuel bill (£)	Average SAP rating	Average FP ratio
1	£1,278	50.5	21.4%	4,333	3%	£1,571	52.0	24.6%
2	£1,195	51.4	11.8%	11,396	8%	£1,174	53.6	11.5%
3	£1,311	50.6	10.5%	9,709	7%	£1,618	48.9	13.1%
4	£1,318	51.1	8.8%	12,701	9%	£1,267	56.8	8.5%
5	£1,364	50.5	7.7%	12,053	9%	£1,466	54.1	8.1%
6	£1,481	49.0	7.0%	20,462	15%	£1,555	51.4	7.2%
7	£1,464	51.4	5.8%	13,744	10%	£1,766	49.3	6.9%
8	£1,564	49.8	5.2%	20,597	15%	£1,637	50.7	5.5%
9	£1,648	50.8	4.4%	16,676	12%	£1,680	52.4	4.6%
10	£1,863	48.0	3.4%	19,029	14%	£1,859	49.3	3.4%
All	£1,448	50.3	8.6%	140,700	100%	£1,584	51.7	7.6%

Source: LiW property and household surveys, 2008

Annex Table A.5 and Annex Table A.6 below show the income distribution of all households in 2008 containing dependent children⁴⁷ and then households with one or more child under five years of age, respectively. Unlike elderly households, this analysis suggests that a higher proportion of households with children are better off than the population as a whole. However, further analysis using alternative adjusted incomes suggests that once the household composition and housing costs are accounted for, this situation is reversed.

Disabled people and people with long term illnesses

There are a number of factors that contribute to making disabled people potentially susceptible to the harmful effects of living in cold homes. Physiologically, certain health conditions increase sensitivity to the cold. Disabled people with mobility impairments or other conditions, such as chronic fatigue, may find it harder to be active in order to keep warm. Disabled people experience high rates of unemployment and, combined with above average living costs, this can mean disabled households are more likely to be on low incomes. Although, in the UK, existing disability payments are paid in recognition of these greater-than-average living costs (Disability Action, 2011). According to the Disability Review Survey, 41 per cent of participants mentioned that their utility bills were higher as a result of their condition (Gore and Parckar, 2009)⁴⁸. Amongst people with long term illnesses, 60 per cent of respondents to a survey of cancer patients stated they had increased expenditure on fuel since being diagnosed (George, Graham and Lennard, 2013). Work by the Papworth Trust (2010) also highlighted that 75 per cent of disabled people are at home during winter for between 8 and 12 hours (virtually the whole day) compared with just 21 per cent of non-disabled people (Snell, Bevan and

⁴⁷ 'Children' in this instance (and generally throughout this report unless specified) refers to any child under 16 or any persons aged 16 to 18 and in full-time education living in the household.

⁴⁸ The Disability Review survey was compiled from responses by 1,253 people across the UK to a detailed questionnaire

Thomson, 2013). For those with chronic illness, living in a cold home may hinder or prevent their recovery (Bevan Foundation, 2010).⁴⁹

Recent changes to the benefits system, including the removal of the Severe Disability Premium (SDP) and the move from the Disability Living Allowance (DLA) to Personal Independence Payment (PIP) are also suggested to have increased the level of fuel poverty amongst the disabled. The Citizens Advice Bureau have reported that 80 per cent of those who were previously eligible for the SDP said they would have to cut back their expenditure on heating as a result (Snell, Bevan and Thomson, 2013).⁵⁰ Such reported perceptions, as opposed to studies based on recorded changes in actual expenditure must be regarded with a degree of caution.

Annex Table A.7: Income distribution and energy situation of households who contain people with a long term illness or disability

Income decile	All households			Long term ill or disabled households				
	Average fuel bill (£)	Average SAP rating	Average FP ratio	Number of households	Proportion of group	Average fuel bill (£)	Average SAP rating	Average FP ratio
1	£1,278	50.5	21.4%	67,855	13%	£1,199	52.9	19.9%
2	£1,195	51.4	11.8%	68,279	13%	£1,153	52.3	11.5%
3	£1,311	50.6	10.5%	70,137	13%	£1,307	50.7	10.5%
4	£1,318	51.1	8.8%	69,060	13%	£1,275	53.5	8.5%
5	£1,364	50.5	7.7%	54,421	10%	£1,366	50.5	7.7%
6	£1,481	49.0	7.0%	56,528	11%	£1,478	50.4	7.0%
7	£1,464	51.4	5.8%	42,880	8%	£1,619	52.3	6.4%
8	£1,564	49.8	5.2%	33,246	6%	£1,506	51.2	5.1%
9	£1,648	50.8	4.4%	33,360	6%	£1,717	50.3	4.6%
10	£1,863	48.0	3.4%	30,422	6%	£1,938	46.3	3.5%
All	£1,448	50.3	8.6%	526,188	100%	£1,394	51.4	9.5%

Source: LiW property and household surveys, 2008

Analysis of the LiW survey suggests that households living with a long term illness or disability comprise the largest single group of vulnerable households; approximately 525,000 (or 40 per cent) of households in Wales included someone with these

⁴⁹ Insufficient details in the literature and no link to survey in the Bevan report

⁵⁰ Based on an online survey of 1,243 disabled people

conditions in 2008.⁵¹ Furthermore, a significant majority of these households are among the poorest in society, with over half (275,000) in the poorest 40 per cent of the population. For each of the four lowest income deciles, approximately half of all households contain someone with a disability or long term health condition.

However, there is significant variation in type and severity of disability and long term limiting illness, as well as in the capability of households and individuals to take measures to overcome, compensate or cope with harmful effects of cold homes.

People suffering with mental health issues

There are a number of studies and reviews that present evidence of the link between cold homes and mental health problems (EAGA Charitable Trust, 2010). The social cost of the mental health issues imposed by cold homes has been calculated as being greater than the combined cost of all other issues relating to cold homes (Stafford, 2015). This is a reflection of the high prevalence of mental health issues, rather than specific mental health issues having a particularly high social cost per case.

It is vital to recognise that the impact of the cold is not felt equally by all; the experience of cold is subjective. A predisposition to mental health issues therefore can have a very strong bearing on how an individual responds to a cold home and how vulnerable they are to suffering. This is recognised by the Warm Front Report that comments that although there is certainly a link between the measured temperature inside a home and stress, there is a stronger association between an individual's perception of the temperature and stress (Threlfall, 2011). People already in a negative frame of mind will struggle more to deal with the misery of cold homes.

Furthermore, as data presented in Annex Table A.8 shows, those suffering with mental health disabilities issues are also more likely to be on low incomes. (This group of households is a subset of the wider group analysed above with long term

⁵¹ The Living in Wales survey was based on face-to-face interviews in 2004 and 2008.

illness or disabilities.) Although this data does not include all those suffering with mental health conditions, it shows that over half of those living with a mental health disability are in the poorest 40 per cent of the population. In 2008, this covered approximately 40,000 households in Wales.

Annex Table A.8: Income distribution and energy situation of households with members who have a mental health disability

Income decile	All households			Households with a mental health disability				
	Average fuel bill (£)	Average SAP rating	Average FP ratio	Number of households	Proportion of group	Average fuel bill (£)	Average SAP rating	Average FP ratio
1	£1,278	50.5	21.4%	10,658	15%	£1,154	54.7	19.6%
2	£1,195	51.4	11.8%	8,721	12%	£1,085	55.8	10.8%
3	£1,311	50.6	10.5%	9,826	14%	£1,138	56.6	9.0%
4	£1,318	51.1	8.8%	10,071	14%	£1,564	52.8	10.3%
5	£1,364	50.5	7.7%	8,297	12%	£1,482	52.7	8.6%
6	£1,481	49.0	7.0%	7,359	10%	£1,254	60.3	6.0%
7	£1,464	51.4	5.8%	6,764	9%	£1,440	50.1	5.7%
8	£1,564	49.8	5.2%	3,282	5%	£1,448	52.4	4.8%
9	£1,648	50.8	4.4%	4,647	6%	£1,640	47.4	4.3%
10	£1,863	48.0	3.4%	2,509	3%	£2,293	42.8	5.0%
All	£1,448	50.3	8.6%	72,134	100%	£1,360	53.7	9.7%

Source: LiW property and household surveys, 2008

People paying for their energy by pre-payment method

Whilst those paying for their fuel by pre-payment meter are not a specific vulnerable group, research has shown that households who use pre-payment meters are typically more vulnerable than households who use other methods of payment. This can be attributed to the fact that the incidence of a number of different vulnerabilities is higher in the pre-payment meter group than in the population as a whole: 28 per cent of pre-payment meter users are lone parents, compared with 19 per cent of non-pre-payment users; 29 per cent of pre-payment users have a mental health-problem compared with 24 per cent of non-pre-payment users; 6 per cent of pre-payment meter users have a learning difficulty compared with 3 per cent of non-pre-payment users. Overall, two thirds of pre-payment meter customers have been shown to have at least one key support issue (Christians Against Poverty, 2015).

The increased incidence of this range of vulnerabilities means that in addition to being more likely to find themselves in a cold home, pre-payment meter customers are also more likely to struggle to deal with the situation. Research done by Consumer Focus in 2010 found that pre-payment meter users were more likely to be low income than the average energy customer: 68 per cent of pre-payment meter customers had an income below £17,500, compared to 38 per cent of those paying for energy by other means (Vyas, 2014). This is also reflected in the financial struggles faced by pre-payment meter customers identified by research looking at the 'heat or eat' dilemma faced by households in extreme poverty. The 2015 study identified that pre-payment meter customers had the lowest median level of spending on fuel and food and that for these customers the decision to spend on fuel rather than food was a recurrent issue (Lambie-Mumford and Snell, 2015).

The struggles faced by pre-payment meter customers in cold homes and the knock on impacts of high fuel bills were also explored in the 2015 Christians Against Poverty paper. Of those surveyed, 60 per cent of pre-payment meter customers had been late in paying their rent (compared to less than 40 per cent of non-pre-payment method customers). Consequently, the survey found that pre-payment meter users were more than twice as likely to have been threatened with eviction and 18 per cent more likely to have borrowed money from an expensive source of credit, such as a pay day lender (Christians Against Poverty, 2015).

Prepayment meter customers are not a heterogeneous group of households, but there is sufficient evidence that highlights the plight of people paying for their energy through this method. While the priority of an energy efficiency scheme is primary about improving the thermal performance of homes, it should be recognised that prepayment households exhibit a number of vulnerable characteristics.

Income status of vulnerable households

The analysis illustrates the income distribution of households from each vulnerable group according to data in the LiW survey 2008. The income used in this analysis is net income (after income tax and national insurance deductions). However, more recent UK-wide data is available from HBAI data. This includes income data that represents around 33 million households across the UK, with the income equivalised to take into account the household composition and allow a more direct comparison of incomes between different types of households. Here, we present further analysis showing the income distribution of the main vulnerable groups identified above. This has used the following household incomes:

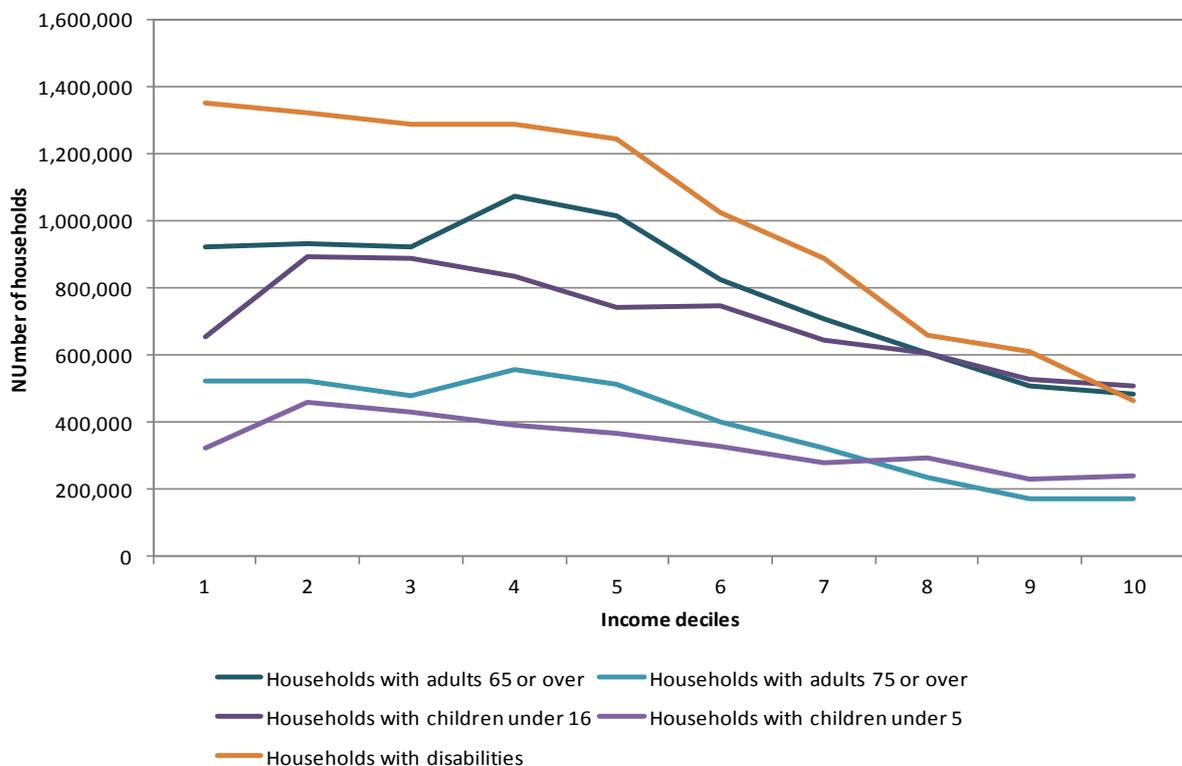
- The equivalised net income, **before** deducting housing costs, of the household
- The equivalised net income, **after** deducting housing costs, of the household

In each case, Organisation for Economic Co-operation and Development (OECD) scales have been used for the equivalisation. Typically, most commentators on income and poverty tend to report on after housing cost incomes. There are two main reasons for this. First, housing cost can vary considerably by region (e.g. London) and by different types of households. For example, pensioner households who have paid off their mortgage, compared with families renting their homes. Secondly, calculations using 'after housing cost' incomes are not affected by matters as whether housing benefit, which typically helps the poorest in society, is considered as an income.

Annex Figure A.2 and Annex Figure A.3 show the numbers of households in each vulnerable group and in each income decile for both before and after housing costs income definitions. (Unfortunately information is not available in the HBAI data to include analysis of people suffering with mental health conditions.)

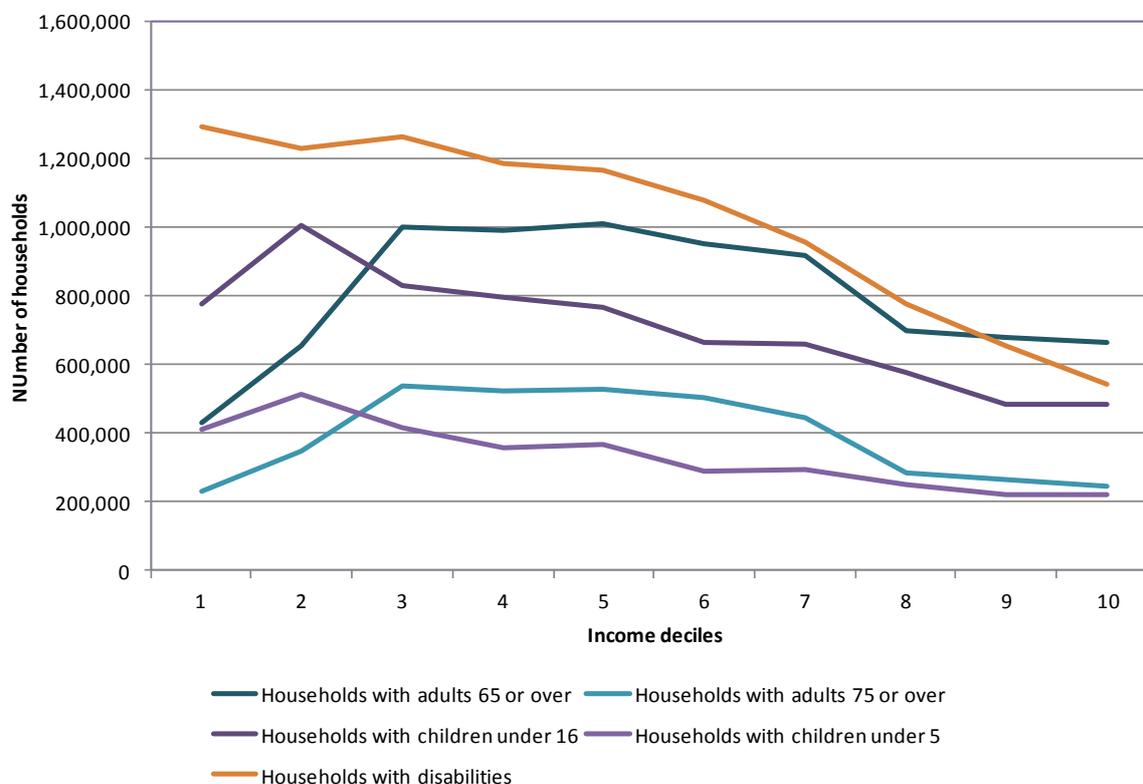
The majority of each vulnerable group have incomes in the lower income deciles, with the proportion of households in the bottom four income deciles (i.e. the poorest 40 per cent) ranging between 46 per cent for households with children to 53 per cent for households with over 75s. However, what is noticeable is that when housing costs are taken into account the profiles of income distributions vary, with less elderly households falling into the lowest income deciles and more households with children being those with the lowest incomes. For example, 28 per cent of households with children under 5 are in the bottom two income deciles using equivalised after housing cost incomes, whereas only 15 per cent of households with over 75s are in the same income bracket (Annex Table A.9). The distribution of the numbers of disabled households across income deciles is not significantly affected when housing costs are taken in to account.

Annex Figure A.2: Before housing costs equivalised income distribution of elderly households, households with children and households with disabled members



(Source: Households Below Average Income 2013-14).

Annex Figure A.3: After housing costs equivalised income distribution of elderly households, households with children and households with disabled members (Source: Households Below Average Income 2013-14).



(Source: Households Below Average Income 2013-14).

Annex Table A.9: Proportion of each vulnerable group in the lowest income deciles, for incomes before and after housing costs

Income type	Income deciles	Children under 16	Children under 5	Adults 65 or over	Adults 75 or over	Disabilities
equivalised incomes before housing costs	Lowest 2 deciles	22%	23%	23%	27%	26%
	Lowest 3 deciles	35%	36%	35%	39%	39%
	Lowest 4 deciles	46%	48%	48%	53%	52%
equivalised incomes after housing costs	Lowest 2 deciles	25%	28%	14%	15%	25%
	Lowest 3 deciles	37%	40%	26%	29%	37%
	Lowest 4 deciles	48%	51%	39%	42%	49%

Source: LiW property and household survey, 2008.

Low income households with multiple vulnerabilities

Analysis of the datasets shows that a significant proportion of households classified as being vulnerable are likely to be classified as have more than one of the vulnerabilities identified. Annex Figure A.4 provides information on low income groups and the main vulnerabilities identified previous. As illustrated, the majority of elderly households also contain a household member with a long term illness or disability. These households account for 28 per cent of all low income homes in Wales. In addition, approximately one third of low income households with children have a household member (either an adult or a child) with a long term illness or disability. In total, 175,000 (35 per cent) low income households can be categorised as being doubly vulnerable to cold homes, as they include elderly people with disabilities or households with children where either the child or an adult member has a disability. These two types of low income households are likely to be the most vulnerable to cold homes, and suffering the most as a consequence.

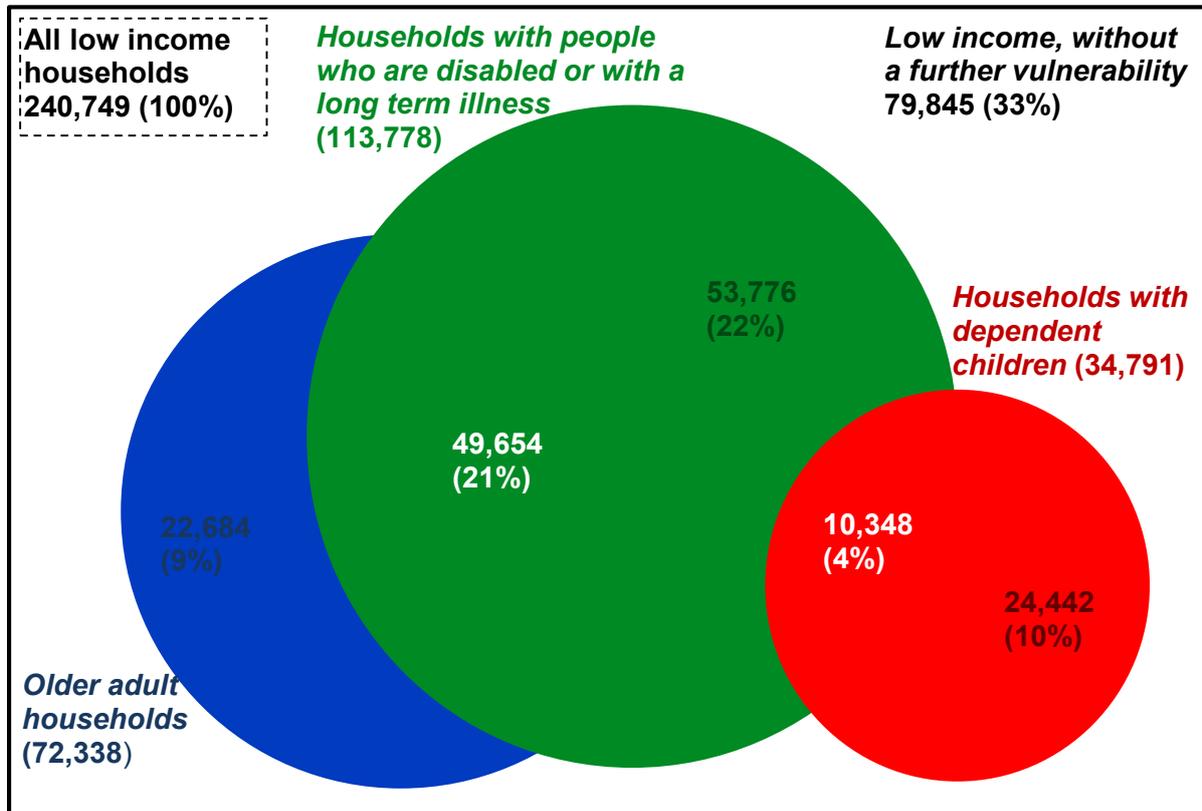
Annex Table A.10 presents some analysis of low income households in Wales, split by different vulnerable groups, including those low income households who do not contain any members who are elderly, young, disabled or with mental health problems, and those households who have more than one vulnerable situation. Each row in the table represents a mutually exclusive set of households.

The two largest groups of low income households are households with disabilities or long term illnesses (but do not contain children or elderly inhabitants) and households with people who are over 75 and with a disability or long term health issue. Both these groups represent over 70,000 households. The average SAP ratings of these homes are 54 and 51, respectively, suggesting that a considerable proportion of these households could benefit from energy efficiency improvements.

It is also worth noting that although low income households with children under five represent a smaller number of people than other groups, approximately a quarter of these households also include an adult or child with a disability or long term illness; There are 28,000 low income households with children under five, with a further 6,000 households containing children under five, and someone with a long term

illness or disability. This latter group have energy costs significantly higher than the low income group as a whole, and an average energy efficiency rating of 44, which is significantly lower than the average rating of 51 for low income households.

Annex Figure A.4: Low income households and vulnerable groups



Source: LiW Survey 2008 (percentages may not sum to 100 per cent due to rounding)

Annex Table A.10: Incomes, energy costs, SAP ratings and average fuel poverty ratios of different low income vulnerable groups, including households with multiple vulnerabilities

Vulnerable group type	Vulnerable group	Number of households	Median income	Average energy costs	Average SAP rating	Average fuel poverty ratio
Individual groups (Households with only one of the vulnerabilities identified)	low income only	92,637	£11,090	£1,289	48.6	14.7%
	Household with dependent children	34,400	£12,606	£1,382	51.5	12.9%
	Household with dependent children under 5	28,277	£11,618	£1,331	54.3	12.7%
	Elderly (over 65)	46,305	£10,521	£1,386	46.2	13.8%
	Elderly (over 75)	31,916	£10,196	£1,269	47.6	13.3%
	Long term illness or disability	73,205	£10,720	£1,247	53.6	14.5%
	Mental health disability	26,807	£9,905	£1,134	55.5	12.9%
Overlapping groups (houses with more than one of the vulnerabilities identified)	Household with dependent children, and long term illness or disability	18,107	£13,100	£1,240	54.9	10.0%
	Household with dependent children under 5, and long term illness or disability	5,839	£11,440	£1,591	44.3	13.4%
	Household with dependent children, and with mental health disabilities	5,724	£12,346	£1,189	61.0	10.5%
	Household with dependent children under 5, and with mental health disabilities	4,023	£13,767	£1,256	59.3	8.9%
	Elderly (over 65), with long term illness or disability	67,536	£11,594	£1,194	51.3	11.7%
	Elderly (over 75), with long term illness or disability	71,366	£11,240	£1,225	50.8	11.9%
	<i>Elderly (over 65), with mental health disabilities⁵²</i>	<i>1,503</i>	<i>£7,793</i>	<i>£1,509</i>	<i>32.0</i>	<i>17.5%</i>
<i>Elderly (over 75), with mental health disabilities</i>	<i>1,219</i>	<i>£16,092</i>	<i>£3,422</i>	<i>26.5</i>	<i>22.1%</i>	
	All Low income households	508,866	£11,388	£1,276	50.9	13.1%

⁵² Figures for Elderly households with mental health disabilities are statistically unreliable due to the small number of cases covering these households in the data set. They should be treated with extreme caution.

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Annex B Producing a Welsh housing stock for the NHM

The objective was to identify a set of English (and possibly Scottish cases) which could be reweighted to resemble the LiW 2008 distributions on key variables.

Measuring resemblance

The idea of resemblance we propose involves producing some exclusive categories for which we can compute the total weight both in LIW and in the NHM stock. For example, if we take built form, tenure, and binned dwelling age we might end up with a table like this:

Built Form	Tenure	Age Band	Weight in Wales
Detached	Owner Occupied	1900-1920	10000
Semi Detached	Owner Occupied	1900-1920	8000
	...		
Terraced	Social Housing	1980-2000	3000

The goal is then to reweight the cases in an existing NHM stock so that (ideally) the total weights in each category match those for Wales. This reweighted stock is then taken to represent Wales. It should be immediately obvious that this is impossible to do perfectly. Consider the following simple example:

Given the following summary of LIW (imagining these are the only two categories that are produced):

Built Form	Tenure	Weight in Wales
Detached	Owner Occupied	1000
Terraced	Social Housing	1000

and an NHM stock that looks like this:

Case	Built Form	Tenure
1	Detached	Social Housing
2	Terraced	Owner Occupied

Here there is no way we can choose weights for cases 1 and 2 which reproduces the summary statistics that we are looking for.

The process we have investigated is a heuristic method for reweighting cases and produces a stock by matching cases to categories and modifying their weights. This process is described in more detail below.

Producing a Wales stock by reweighting categories

The simple heuristic we will implement is as follows:

- Given a set of dwellings with total weight D , we can define a procedure for reweighting them to instead have a total weight W . This could be as simple as multiplying each weight by W/D , or a more complicated method like randomly picking cases until the weight exceeds W and then scaling that subset only (setting the rest to zero) could be employed.
- Given this procedure, if we have a stock and a target summary table as above, we can produce a reweighted stock by distinctly allocating cases in the stock to rows from the summary table and using the procedure to reweight the cases associated with a row to the target weight in that row.
- Cases can be allocated to a row in the target table by choosing an ordering on the relevant variables (the columns), and recursively partitioning the stock on those variables. In the event that cutting by a particular variable would leave no cases associated with certain rows, we skip over that variable for those cases.

In order to illustrate the method we will employ, we provide the following example: consider the following summary table and stock (A-D are some set of dwelling attributes that can be found in both data sets and are important):

A	B	C	Weight in Wales	Row
1	1	1	100	i
1	1	2	400	ii
1	2	1	300	iii
2	1	1	300	iv
2	2	2	200	v
2	1	2	800	vi
1	2	2	600	vii

Stock:

ID	A	B	C
1	1	1	1
2	1	1	1
3	1	2	1
4	2	2	1
5	1	2	2
6	2	1	1
7	2	1	1
8	1	1	2

Then if we choose to take the columns in order A, B, C then we have:

- Divide by A, giving us the populations from the stock:
 - A = 1: 1,2,3,5,8

This must be matched with the sub-table

B	C	Weight in Wales	Row
1	1	100	i
1	2	400	ii
2	1	300	iii
2	2	600	vii

So we divide this by B, giving:

- A = 1 and B = 1: 1,2,8

This must be matched with the sub-table

C	Weight in Wales	Row
1	100	i
2	400	ii

So we divide this by C, giving

- A = 1 and B = 1 and C = 1: 1,2

This subset belongs to row i of the LIW table, so we use our choice of weighting rule to reweight cases 1 and 2 to have a weight of 100

- A = 1 and B = 1 and C = 2: 8

This subset belongs to row ii of the LIW table, so we reweight case 8 to have a weight of 400

- A = 1 and B = 2: 3,5

This must be matched with the sub-table

C	Weight in Wales	Row
1	300	lii
2	600	Vii

So we divide this by C, giving

- A = 1 and B = 2 and C = 1: 3 only, which is associated with row iii
- A = 1 and B = 2 and C = 2: 5 only, which is associated with row vii

- A = 2: 4,6,7

This must be matched with the sub-table:

B	C	Weight in Wales	Row
1	1	300	lv
2	2	200	v
1	2	800	Vi

So we divide by column B, giving

- A = 2, B = 1: 6, 7

This must be matched with the sub-table

C	Weight in Wales	Row
1	300	lv
2	800	Vi

So we divide this by C, giving

- A = 2, B = 1, C = 1: 6, 7
- A = 2, B = 1, C = 2: **No dwellings in the stock**

Because at this point we would have no dwellings like row vi, we skip over column C in this case, and assign a total weight of 300+800 to dwellings 6, 7; they belong to rows iv and vi.

- A = 2, B = 2: 4

This must be matched with the sub-table

C	Weight in Wales	Row
2	200	v

Dividing by C, we have

- $A = 2, B = 2, C = 2$: **No dwellings in the stock**

Again, there are no dwellings in the stock which exactly match row v. Instead, we skip over column C here and say that dwelling 4 is the best we can do, assigning it a weight of 200.

The final result is then as follows:

A	B	C	Weight in Wales	Rows	Cases from Stock
1	1	1	100	i	1, 2
1	1	2	400	ii	8
1	2	1	300	iii	3
2	1	x	300+800	iv+vi	6, 7
2	2	x	200	v	4
1	2	2	600	vii	5

And we apply an appropriate procedure to the set of cases from the stock in each row to produce a total weight equalling the target weight for that row.

Intuition suggests that the marginal distributions of weight on earlier columns are more likely to be preserved, and this does allow control of the weight selection method to prevent the creation of very low weights. In addition it is a simple algorithm to implement in something like R, and is not computationally expensive.